RePublic_ZEB
ZEROING IN ON ENERGY

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REPORT D2.2: METHOD AND RESULTS IN DEFINING NATIONAL REFERENCE BUILDINGS FOR EACH BUILDING CATEGORY

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Project consortium

BME	WP3 Leader
BRE	WP6 Leader
BSERC	WP2 Leader
CRES	Partner
CTI	WP1-WP7 Leader Coordination
EIHP	Partner
URBAN-INCERC	Partner
IREC	Partner
LNEG	WP5 Leader
MACEF	Partner
POLITO	WP 4 Leader
ZRMK	Partner

Project overview

The RePublic_ZEB project is focused on the energy and CO_2 emissions associated with existing public buildings and their refurbishment towards nZEB.

The **core objective** of the project is to:

- Define costs-benefit optimized "packages of measures" based on efficient and quality-guaranteed technologies for the refurbishment of the public building stock towards nZEB that are standardized and adopted by builders and building owners.

From this stems three **basic objectives:**

(i) State-of-the-art assessment of the public building stock through a country-specific evaluation of the energy consumption and CO_2 emissions;

(ii) Define reference buildings; and;

(iii) Develop a common framework and a harmonized methodology for the definition of a nZEB concept for public buildings.

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LIST OF ABBREVIATIONS

COP	Coefficient of performance
DHW	Domestic hot water
EER	Energy efficiency rating
EPC	Energy performance certificate
GF	Ground floor
GHG	Green house gas
ISO	International Organization of Standardization
nZEB	Nearly-zero energy buildings
RES	Renewable energy sources
SPEC	Specific primary energy consumption
VRF	Variable refrigerant flow
WP	Work package
CO_2	Carbon dioxide

EXECUTIVE SUMMARY

This document represents Deliverable (D2.2), which contains the results of the second stage of the work within WP2 - Method and results in defining national reference buildings for each class. Deliverable D2.1: "Report on the preliminary assessment of public buildings stock" includes detailed information regarding public buildings in the eleven countries, covered by the project. As a result of the adopted definition of reference buildings and the carried out analyses of the public building stock, a preliminary selection of reference buildings has been made.

Based on this information, **Chapter II: Selection of Building Categories** of the current report contains the final list of building categories, reference buildings of which have been chosen for further detailed analysis.

The following criteria have been applied for the choice of representative categories:

- Building conditioned area, m2,
- Specific final/primary energy consumption, kWh/m2.year, and/or
- Quantity of CO2 emission equivalent of the specific energy consumption, kg/m2.year

In line with the RePublic_ZEB Grant Agreement, each country has presented at the minimum two categories of buildings. However, depending on the importance of certain categories in given countries this number has been increased to 4-5.

Chapter III: Selection of Reference Buildings, presents the choice of reference buildings for each building category, based on the following criteria:

- Built-up/conditioned floor area;
- Building age;
- Construction materials and corresponding thermal properties of the building envelope;
- Occupancy schedule;
- Technical systems/installations for maintaining the built environment;
- Operational pattern;
- Energy carriers used for heating.

Necessary data were seek for each country targeted by the project, starting from official information available through the national and regional specialized institutions, as well as using the results of existing studies. In cases when relevant data were not found, the use of default data was agreed.

The whole information is presented in the form of tables, which have been developed for the aims of this particular investigation. This approach allows the application of building energy modelling and simulation for obtaining the energy performance of the buildings in WP4. The building energy model encompasses 12 groups of necessary information: geometrical, internal gains and operational schedule, building energy usage, base heat supply regime (type of the heating system, energy resource etc.), cooling mode and system, ventilation etc., which would allow performing simulation of the energy consumption.

The sets of relevant information concerning the eleven countries, covered by the project, are included as an Appendix to the main report.

1 Introduction

The achievement of best results from the project work is determined by the choice of building categories for further analysis, which have the biggest influence on the generation of CO_2 emissions. It is expected that these shall be the categories of buildings with the highest energy consumption, although the emissions, to a great extent, depend also on the type of energy consumed and its emission factors.

The available information regarding public buildings does not allow getting deeply into the structure and emission characteristics. That is why, for the needs of the buildings classification in the current study, it is assumed to use characteristics such as conditioned area and specific final or primary energy consumption for unit conditioned area, which define the greatest energy saving potential.

A reference building could be a real or imaginary building, which to the greatest extent reflects the performance of the group/category it represents. Usually, depending on the performance of each building category, it becomes necessary to include sub-categories and therefore, to choose several reference buildings, which would make the investigation sounder.

Despite the similarity of the definitions of the buildings classes, it is possible to notice significant differences in their relative weight in the overall building stock of the given countries. This is due to the difference in the ownership of the used public buildings.

2 Selection of building categories

The nowadays' energy policy rests upon the pursuit of climate protection through admissible energy comfort for consumers. This aim is obligatory also while choosing categories of buildings and hence, it defines the performance of the specific criteria. These criteria should help the forthcoming investigation to reach maximum effectiveness, and through the proposed measures for improvement of consumption's efficiency – the highest reduction of GHG emissions. This requirement could be met by criteria, which reflect both the volume of the used energy by category, and the effectiveness of consumption; and at the end – the biggest reduction of emissions with observation of consumers' comfort.

The choice can be done without following formal procedures, but with consideration of the above argumentation.

The first apparent criterion is the **conditioned area** relevant to the given building category. It is the first-rate indicator, which defines the volume of the energy needed for conditioning, while observing the restrictions of space comfort. It defines the potential for saving of energy, of course depending on the specific primary energy consumption.

Obviously, the building's **total floor area** is not the needed accurate indicator, but its application is acceptable in situation when no information is available about the conditioned area.

The mentioned **specific primary energy consumption** (SPEC) is the second valuable indicator, which, thanks to its omnipurposeness incorporates also the efficiency of conversion processes. Through them it reaches the consumers and successfully adds value to the first indicator (conditioned area).

The inevitable conversion inaccuracies during the SPEC identification reduce the accuracy of this indicator and make it not better than the **specific final energy consumption** indicator. Connection between both indicators is the efficiency of conversion, which highly depends on the type of energy used and the efficiency of the used national and local energy technologies. For example, electricity

generated by thermal power plants loses 70% of fuel's energy until it reaches the consumers connected to the low voltage grid.

These three indicators are sufficient to choose the buildings categories; however, if information is available, it is advisable to use the direct indicator – **CO2 emissions equivalent**. Of course, for large groups of buildings it is also tentative.

Resting on the above considerations, the basic approach proposed for selection of categories of buildings, for which representative buildings for further cost-benefit analysis will be determined, includes assessment of the building classes identified at the previous stage, observing the importance and the magnitude of the following indicators:

- Building conditioned area, m^2,
- Specific final/primary energy consumption, kWh/m^2.year, and/or
- Quantity of CO_2 emission equivalent of the specific energy consumption, kg/m^2.year

Each partner had to select 2-3 or more building categories.

Of course, each country could, according to the specific features of given groups of buildings, examine categories, which do not entirely meet the proposed indicators but are important for the country due to other specific reasons.

2.1 Bulgaria

Deliverable (D2.1) provides information about the public building stock categories, which allows making the choice. In Bulgaria, the overwhelming class of buildings are the educational ones with the share of more than 75,4% of the total conditioned area. These have to be unconditionally included in the study. Three out of the seven remaining categories have been selected, due to their high specific consumption, despite their small share in the total conditioned area. The information regarding the selected building categories is presented in the table below.

Proposed classes for further analyses, Bulgaria

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^2year	CO2 emission equivalent, kg/m^2.year
Residential	6,6	161,6	n/a
Offices/Public administration	3,1	138,1	n/a
Educational buildings	75,4	91,8	n/a
Health-care facilities	6,0	196,68	n/a

The following categories of buildings have been chosen: Students' housing, offices, educational buildings, health-care facilities.

The selection of category "Students' housing" was made because the exploitation of these buildings coincides with that of the residential buildings, which represent a significant part of the whole building stock. In this way the residential sector will be assessed as well.

Health-care facilities have to meet very high requirements towards microclimatic parameters and therefore it is necessary to assess the applicability and achievability of the requirements concerning nearly-zero energy consumption for this category.

Educational buildings are a wide-spread category with significant social importance. A considerable part of them includes sports facilities and swimming pools, in which the application of systems that utilize renewable energy is highly economically and ecologically efficient.

Office buildings are visited by significant masses of people and, along with the necessity to maintain the microclimatic parameters (including air cleanness), the application and demonstration of the efficiency of the principles of nearly-zero energy buildings will have a social impact on visitors, will raise their acquaintance and will improve the quality of the services provided.

The selection of the above buildings' categories has been coordinated with the Ministry of Regional Development and Public Works, Ministry of Energy, Sustainable Energy Development Agency, Bulgarian community of HVAC engineers, Bulgarian Association "Doors, windows, double skin facades", as well as with suppliers of modern HVAC and lighting systems. The chosen categories are treated with priority for financial support by the Operational Programmes during the period 2014-2020.

2.2 Croatia

Building stock by use shows three significant uses – healthcare, administrative buildings and residential buildings, built in the period between 1971 and 2005, which have potential in scope of RePublic_ZEB project. Distribution of buildings between two reference climate which follows general building stock distribution is not available in detail, but 75/25% split may be applied between continental and coastal climate. For residential buildings technological solutions and requirements might be too distinct from non-residential use, and further analysis might not be recommendable.

Building data for public buildings was provided by Ministry for construction and physical planning, as part of the national plan for refurbishment of public building stock, directing the refurbishment to offices and public administration buildings. Further information on building stock energy consumption used in analysis was given by Agency for transactions and mediation in immovable properties, which is running ISGE database of public buildings (collecting data on energy consumption). Total share of buildings stock, possibilities for refurbishment, and expected visibility of nZEB refurbishments directed proposed building uses to office and health care buildings.

Ministry for construction and physical planning is among other in charge of EPBD and EED implementation in Croatia, through adoption of national regulation on energy efficiency in buildings. Agency for transactions and mediation in immovable properties is governmental agency in charge of energy refurbishments of public buildings funded by the Environmental protection and energy efficiency fund.

Proposed classes for further analyses, Croatia

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Residential	22	154,27	n/a
Offices/Public administration	32	118,25	n/a
Health-care facilities	22	196,81	n/a

2.3 Greece

The main criteria for the analysis of the Greek public building stock are:

- number of buildings,
- total floor area,
- building energy performance (final and primary energy consumption).

This analysis showed three building uses that have considerable impact; offices/public administrative buildings, educational buildings and healthcare buildings. Healthcare buildings are not included because it is very difficult to define one reference building due to the variety of the building structure and use (various health care facilities in each hospital).

In the table below, there are two set of energy data. The first one refers to specific final energy consumption and derives from the National Statistical Service of Greece and other sources (national bibliography, and relevant ministries) and the second one refers to specific primary energy consumption and derives from the EPC database.

Proposed classes for further analyses, Greece

Building category	Share of the total conditioned area, %	National Statistical Service of Greece		EPC database	
		Specific final energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year	Specific primary energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Offices/Public administration	22,9	136,0	n/a	271,5	153,5
Educational buildings	52,4	53,5	n/a	101,7	58,8

As mentioned above, three building uses were preselected based on the number of buildings, total floor area and building energy performance. The data were collected from the National Statistical Service of Greece, the School Buildings Organisation S.A., the Ministry of Health, the Hellenic Agency for Local Development and Local Government, energy audits made by CRES, and the Energy Performance Certificate national database. The analysis showed that hospitals and other institutional care buildings have impact as regards total floor area and energy performance. However, based on the available data from the data collection it results that the building geometry and building use varies significantly and there is no reference building to be defined and describe the majority of this building use.

2.4 Hungary

The selection of reference building categories was made on the basis of the National Building Energy Strategy. The document contains reliable information about the Hungarian building stock, since it presents the existing status of residential buildings, as well as public buildings, including building numbers, building structures, energy consumption, etc. The document proposes several building retrofitting measures in different levels of refurbishments. The National Building Energy Strategy was prepared by ÉMI Non-Profit Llc on behalf of the Ministry of National Development and was adopted by the government in 2015. ÉMI is a 100% state-owned professional, intellectual competency center in the Hungarian construction industry. ÉMI's service includes, inter alia,

providing technical expertise for preparation of standards and laws. The selection of reference building categories and reference buildings was made by the involvement of ÉMI. In Hungary, the educational buildings represents 60% of the public building stock, therefore it is the building category that was selected firstly. Health-care facility buildings are another building category that has been considered for further analysis in the project, because it represents 15% of the building stock, and almost 20% of the total primary energy consumption. The third significant building class is the office buildings: these buildings have approximately 8% share of the total conditioned floor area. There are a number of residential buildings owned by central or local authorities, therefore this class was also selected, although there is not available information yet about the share of residential buildings in the public building stock. To sum up, educational, health-care facility, office and residential buildings have been selected as representative building categories of Hungarian public building stock.

Proposed classes for further analyses, Hungary

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Health care facilities	15,2	282	n/a
Offices / Public administration	7,5	226	n/a
Educational buildings	60,1	230	n/a
Residential	n/a	n/a	n/a

2.5 Italy

The main criteria applied for the Italian analysis of the public building stock are:

- building end use;
- public ownership and/or use;
- number of buildings;
- total floor area;
- primary energy consumption for heating, DHW, cooling and lighting.

First of all, different building categories have been considered, according to their public use and/or ownership. For the same categories, the building consistency has been defined. Finally, data on the building primary energy consumption for heating and DHW (conversion factor, 1) and the electricity use for cooling and/or lighting for the non-residential categories (conversion factor, 2,17) have been collected.

Italian public building stock definition through indicators

	PUBLIC		Number of units	Total floor area, m^2	SPECIFIC PRIMARY ENERGY CONSUMPTION, kWh/m^{2}a		
Building category	Use	Ownership			Heating and DHW	Cooling and/or lighting	Global
Residential	X	X	90 000	-	177	-	177

(Social housing)		X					
Offices (Public admin.) (Local authorities)	X X	X	13 700	23 600 000	127	119	246
Education (Schools)	X X	X	52 000	73 400 000	111	41	152
Hotels	X		25 845	48 600 000	150 heating 200 DHW	217	567

Table IT.1 shows the considered categories generally owned and not only attended by publics; with the exception of the hotels. Schools are the category with the highest total floor area; the social houses total floor area is not available, however the number of residential buildings let suppose a high value. Concerning the energy consumption:

- the offices and the residential buildings get the same specific primary energy consumption;
- the social houses energy need for heating and DHW is really high; that is a mean value defined by considering the whole country, peak values arise up to 250 kWh/m^{2}a;
- the schools energy need for heating and DHW could be compared to that of offices, but the electrical consumption is lower because of the minor amount of cooling systems and facilities in general;
- the hotels are an exception, for the relevant use of DHW and electricity referred to the given building services.

The Italian government is particularly interested in offices and schools energy refurbishment, these two categories have thus been chosen for the next work steps. Despite the high energy consumption, hotels have not been chosen for further analysis because this category in Italy is not properly considered as public. Table IT.1 shows also the high number of residential buildings in Italy owned by publics and generally used by privates; this strong impact as well as the high energy consumption referred to this category led to the choice the social houses is the third category to be considered for the further project work, unlikely the lack of available data.

Social houses, schools and offices are thus the three categories considered in Italy for the refurbishment of the public building stock towards nZEB. This selection has been taken and confirmed after a consultation with the Italian Ministry for the Economic Development (MiSE; responsible for the adoption of the EPBD in Italy) through the first “on on one” meeting (as activity of WP5 of the project in December 2014). The same categories have been also included in the “National Plan for nZEB”, presently under development by MiSE. In the consultation process, also the Energy Departments of two important regions (Lombardy and Piedmont in which is present the 25% of the Italian population) have been involved.

2.6 Portugal

The criteria for identifying the reference building in study, follows the analysis of the Portuguese public building stock developed in the report D2.1. As was suggested in the end of this deliverable, the following categories were identified: office and educational buildings should be considered as main categories taking into account a significant impact in terms of building floor surface and energy consumption at the level of building stock. Residential building (social housing) and Health (hospitals) were suggested as well, as second categories that could be considered taking into

account the impact in terms of building floor surface and energy consumption at the level of building stock. The final decision of proposing office buildings and social housing is due to the impact that could bring the rehabilitation process in Portugal. Educational buildings had already pass through rehabilitation process and programs, so another analysis regarding this category is not useful in this stage. Regarding the Health buildings-hospital there exist a large variety in typology representing health buildings, from small health centers to large hospitals and the data available are not very qualitative.

Cost optimal methodology has been applied in Portugal in the case of new building office, need for the methodology applied for existing building (rehabilitation) is still need. In the case of residential buildings, the cost-optimal methodology was applied as well, however the social housing represent a particular case from the point of view of area, geometry and utilization.

The two reference buildings are presented in the following table according with the share of total conditioned area and specific annual final energy consumption categories was mentioned in the one to one meeting.

The data considered for analysis represents the buildings belonging to Public administration, Central authorities and Regional Local Authorities and is based on the information from the EPC data base of National Energy Certification System (SCE).Within first "one to one" meeting with the General Directorate for Energy and Geology, institution responding for the building certification and plans in Portugal, the project and the objectives were presented together with the work plan and explanation of categories of building identified for the analysis.

Proposed classes for further analyses, Portugal

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Residential (Social housing)	23	129,02	n/a
Offices/Public administration	22	48,60	n/a

2.7 Romania

Based on the main conclusions of the analysis of public building stock, the two selected representative building categories are (I) Offices/Public administration and (II) Educational buildings. Furthermore, taking into account the consultations with representatives of the relevant national public authority and the outputs of the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements, the reference buildings were defined for office buildings (Central authorities – Administrative Buildings) subcategory and School buildings subcategory.

According to the analysis of the public building stock in Romania (from inventory of existing buildings owned and occupied by central administration and adding estimated building data from local public administration – mainly offices and schools), the biggest share, in terms of total floor area and primary energy consumption, is represented by office buildings (30% of total floor area and 36% of total primary energy consumption) and by educational buildings (56% of total floor area and 51% of total primary energy consumption).

Proposed classes for further analyses, Romania

Building category	Share of the total conditioned area, %	Specific primary energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Offices/Public administration	29,7	474	89,9
Educational buildings	55,7	358	74,7

One should notice that the largest percentage of the 'inventory of buildings heated and/or cooled useful surface of 500 square meters, owned and occupied by central government' (which does not include local administration buildings and most of the education buildings (from kindergarten to high schools and VET units), which are under the authority of regional/local scholar inspectorates and local councils responsibility) is occupied by office buildings.

Regarding the education buildings, which is the building category with the highest share in the full building stock in Romania (along public office/administration buildings), one should mention the lack of mechanical ventilation systems, which lead to inadequate ventilation in many classrooms (considered to be the main cause of students' performance reduction and health symptoms). Moreover, it is a usual practice in schools renovation to increase the air tightness of building envelope without installing controlled ventilation systems. This will be the focus of all packages of technical solutions which will be provided within the RePublic_ZEB project.

One reference building has been selected for each of these building categories, taking into consideration the average characteristics (total floor area, shape, thermal characteristics, use and primary energy). One should note that the building stock data did not permit the detailed definition of a virtual building (average statistical characteristics), but facilitated the choice of existing buildings which are similar to the average performance of the considered building categories in the public building stock.

The two defined reference buildings are presented in Table RO 1 and Table RO 2 (in Appendix of this report), detailing the necessary data which would allow performing simulation of the energy consumption (geometrical, building energy usage, base heat supply etc.).

The selected buildings are similar to the ones included (for existing buildings) in the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements and in the definition of the Plan to increase the number of buildings with nearly zero energy consumption. The consideration of these buildings for further analysis in RePublic_ZEB project gives the opportunity to go further with more ambitious interventions on the existing situation and to compare and evaluate the results on national and European level. The plans for future work and main goals in the project were presented to the stakeholders on the Ministry of Regional Development and Public Administration (General Directorate for Regional Development and Infrastructure) within a first «one to one» meeting. In this context, it is considered that the implementation of planned programs for energy efficiency in buildings (e.g. cohesion funds) could be supported by the outputs of the cost-effective analysis of renovation measures which will be performed in the IEE RePublic_ZEB project framework.

2.8 Slovenia

The main criteria applied in the analysis of the Slovenian public building stock are:

- Total floor area,
- Total delivered energy,

- Primary energy,
- CO_2 emissions.

Although the Slovenian building stock is rather old, the county itself is rather young. In the past, no research has been done on non-residential building stock throughout the 24 years, which consequently means that much is unknown about the service building sector. The Slovenian authorities are therefore very interested in the deeper analyses from the RePublic_ZEB project. The latest report on "Cost optimal methodology" offered only the first glance on the subject of reference office buildings. Thus, five categories have been chosen for the further work: office, kindergarten, schools, health care facility and social housing.

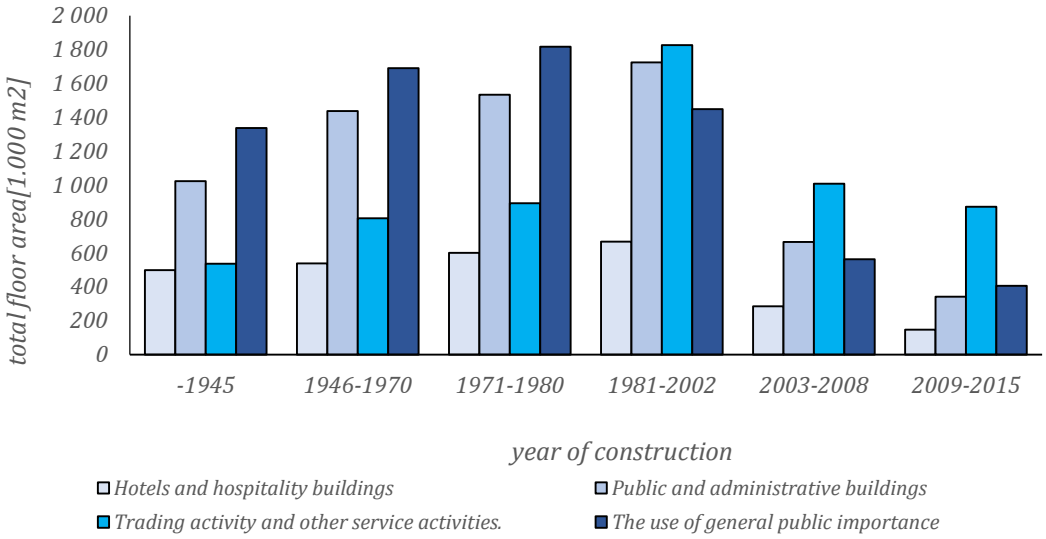

Figure SI 1: Age structure of the non-residential buildings (Register of Real Estates, 2014)

Recent analyses on the entire building stock showed that the chosen five categories represent the largest part of the heated non-residential buildings. Until this year, no platform has been yet established that would enable regular monitoring of building's energy consumption, e.g. public buildings. In 2015, such register is going to start operating and will enable regular monitoring of e.g. renovations and energy consumption of those buildings. For the purpose of this work, the energy consumption was observed in the register of calculated and measured EPCs. The later consists of older buildings, while new buildings in majority have a calculated EPC. Values of specific energy cannot be compared directly, since there are reasons for its differentiation. One of them is the use of the building, where different influence of the users of the building is included – "standard use of the building" on calculated EPC being the most basic. However, such an overview can show behaviour, the actual consumption and gaps for energy savings. Based on the following table it is able to conclude:

- office buildings, social housing and health-care facilities are the ones, which consume the most energy,
- with respect to the represented total floor area, office buildings have the biggest potential for renovation and the biggest progress in total can be made,
- all included buildings have a major consumption of electric energy, which can be lowered with the use of RES technologies.

Proposed classes for further analyses with indicators, Slovenia

Building category	Total floor area*	Total delivered energy			Primary energy		CO2 emission equivalent	
		Calculated EPC	Measured EPC		Calculated EPC	Measured EPC	Calculated EPC	Measured EPC
	1000 m^2	Total, kWh/m^2year	Fuel, kWh/m^2year	Electricity, kWh/m^2year	kWh/m^2year	kWh/m^2year	kg/m^2year	kg/m^2year
Offices/Public administration	1042	164	140	181	236	565	27	115
Educational buildings - kindergarten	319	116	114	127	144	383	35	77
Educational buildings - schools	1998	107	75	72	112	247	28	50
Health-care facilities	713	217	92	153	289	465	81	96
Social housing	942	131	230	138	162	559	44	111

*corresponding to the 2012 data

Despite the fact, that a lot of work has already been done within national strategic documents, FP7 and IEE projects, the analysis of public buildings in Slovenia remains an area that should be given more attention and focus. The vast majority of analysis, concerning the energy efficiency of buildings, was made for office buildings only. Taking this into account, five different categories of public buildings were proposed for further analysis in the frame of RePublic_ZEB project, in order to further extend the knowledge and behaviour of such buildings on several levels (energy consumption, thermal comfort, cost effective measures). Furthermore, it is essential to compare and evaluate the results on national and European level, as well as gain the knowledge and experiences from project partners. This approach gives more insight and confidence while treating non-residential buildings, which are known by their diversity of architecture and use of the building. The plans for future work and main goals in the project were presented to the stakeholders on the Ministry for infrastructure (Head of Energy Directorate Division) and Ministry for Justice (Head of Directorate for Investments and Real Estate) on our first and second »one to one« meeting. The proposition was accepted with support, since many public buildings are going to be renovated in the future and the main focus in the next years is going to be renovation of buildings of the central government. In order for the authorities to award grants from e.g. cohesion funds, the authorities must be aware of cost effective measures, which the IEE RePublic_ZEB project gives.

2.9 Spain (Catalonia)

Based on the analysis of the building categories, two classes for further analysis are proposed:

Proposed classes for further analyses, Spain

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^2year	CO2 emission equivalent, kg/m^2.year
Offices/Public administration	15	99,2	n/a
Hospitals	6	293	n/a

In coordination with the Catalan Energy Agency (ICAEN), responsible of the Energy performance certificates, it has been decided to work with two reference buildings, one office building and one hospital building. The real buildings have been selected together with ICAEN, in the one-to-one meetings. The reason to select offices is that a considerable amount of buildings exists in this category and hospitals are very energy intensive. This selection of reference buildings will contribute to have a good overview of the public building stock and energy performance towards nZEB in Catalonia, together with the work carried by other IEE projects working in nZEB buildings, like ZEMEDS, focusing in schools and in STEP-2-SPORT, focusing in sport buildings.

2.10 the former Yugoslav Republic of Macedonia

The decision of the proposed classes as referent classes included the relevant stakeholders. Their involvement was part of the one-to-one meetings held as part of the WP 5. The consulted stakeholders were the Energy Agency and the Ministry of Economy.

The public building stock data included several classes of buildings:

- Residential
- Offices / Public administration
- Educational buildings, and
- Health-care facilities

During the meetings with the stakeholders, each class of building was discussed.

Residential public buildings are consisted of student housing. This class of building has small share in the total floor area of the buildings.

Offices and public administration buildings have similar share in the total floor area as the residential public buildings. The difference with this class of buildings is that the flow of people is greater. Many of the administrative offices have also service activities and the flow of people is significant in this case.

The educational buildings include kindergartens, schools and universities/ high schools. The educational buildings share in the total floor area is dominant. The flow of people is also bigger that the rest of the classes.

The health care facilities have specific energy consumption. Stability in the energy supply is also crucial due to the sensibility of the processes that take place in this kind of buildings. Further analysis would be necessary for implementing measures in this class of buildings.

The conclusion of the reference classes of buildings was that Offices / public administration and educational buildings will be considered. As factor for the decision, the share in the total floor area of the class of buildings and the flow of people had most influence.

Proposed classes for further analyses, the former Yugoslav Republic of Macedonia

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Offices / Public administration	5	241	n/a
Educational buildings	67	224	n/a

2.11 United Kingdom

After a first analysis of the public building stock categories, we went through the process of selecting the building categories for the study. In the UK, educational and office buildings represent an important share of the total conditioned area as shown in D2.1. Moreover, they have high specific energy consumption due to their age and so offer significant opportunities for energy savings. As a consequence, we included these two categories in the study with two main sub-categories of offices, with different characteristics which are representative of office types categorised in a best practice publication (ECON19) produced by the UK's Carbon Trust. The building types selected were also comparable to those used in the UK's EPBD cost optimal report for the Commission.

Once the categories were selected, we gathered information for one representative building for each category and completed the template accordingly. When information was missing, we either used the default data from the database from the UK's national calculation methodology for energy performance (SBEM) for the corresponding building type, or made reasonable assumptions. Specifically, we used the SBEM database for the following fields:

- Fraction of the window frame area
- Infiltration (occupancy and non-occupancy period)
- Lighting and appliances (occupancy patterns)
- Set-point temperatures
- Distribution efficiency for the heating system

We made assumptions in some cases:

- Number of holidays
- Emissivity and absorbance of walls

Proposed classes for further analyses, United Kingdom

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m^{2}year	CO2 emission equivalent, kg/m^2.year
Offices/Public administration (Victorian office – Type 1)	13 (office floor area as % of the total public sector floor area)	302	87
Offices/Public administration (1960s office – Type 2)	13 (office floor area as % of the total public sector floor area)	249	82

3 Selection of reference buildings

3.1 Definition of data

The reference building for a building category/Subcategory can be defined as a building with representative for the building category parameters as follows:

- Built-up/conditioned area;
- Building age;
- Construction materials and corresponding thermal properties of the building envelope;

- Occupancy schedule;
- Technical systems/installations for maintaining the built environment;
- Operational pattern;
- Energy carriers used for heating.

3.2 Data collection

All necessary data: geometrical, building energy usage, base heat supply regime (type of the heating system, energy resource etc.) etc., which would allow to perform simulation of the energy consumption, should be collected.

A template for reporting has been designed as shown in Table 1.

Table 1: Template for reporting the reference building input data

Building category			
Subcategory			
Conditioned area	m^2	Based on internal dimensions, external dimensions or overall internal dimensions	
Conditioned volume	m^3		
Climatic zone		Ref. number: City:	
Part 1: Building (Zone) geometry			
Walls, north	m^2	Total wall area excl. windows and doors	
Walls, east	m^2	Total wall area excl. windows and doors	
Walls, south	m^2	Total wall area excl. windows and doors	
Walls, west	m^2	Total wall area excl. windows and doors	
Windows, north	m^2	Window area incl. frames	
Windows, east	m^2	Window area incl. frames	
Windows, south	m^2	Window area incl. frames	
Windows, west	m^2	Window area incl. frames	
Roof	m^2		
Floor	m^2		
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment	Requirement at 2014
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-	Adjustment factor b to the ground	
b(un-conditioned space)	-	Adjustment factor b to unconditioned space	
b(adjacent sunspace)	-	Adjustment factor b to adjacent sunspace	
b(adjacent building)	m^2	Adjustment factor b to adjacent building	
Uwindows	W/m^2K	Prior to investment	Requirement at 2014

fraction of the window frame area	%		
g(F)	-	Total solar energy transmittance for window incl. external shading.	
Uroof	W/m^{2}K	Prior to investment	Requirement at 2014
Ufloor	W/m^{2}K	Prior to investment	Requirement at 2014
ε	-	Emissivity for external walls (depending on type of materials and surface)	
α	-	Solar absorption for external walls (depending on type of materials and surface)	
Infiltration, occupancy period	h^{-1}		
Infiltration, non occupancy	h^{-1}		
Thermal capacity	Wh/m^{2}K		
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	Average metabolic heat during the operation period	
Latent metabolic heat	W/m²	For cooling calculations	
Weekdays	h/day	No. of hours with the metabolic heat for a normal weekday	
Saturdays	h/day		
Sundays	h/day		
Lighting for illumination	W/m²	Average lighting power during the operation period	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Lighting, emergency/controls	W/m²	Average lighting power during the operation period	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m²	Average simultaneous power from appliances during the operation period	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Latent heat	W/m²	For cooling calculations	
Weekdays	h/day		
Saturdays	h/day		

Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)												

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 6: Heating system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Energy source (fuel, energy carrier)	-	
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				

Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)

Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

4 Conclusions

Deliverable (D2.2) aims at providing reliable information about the technical and exploitation characteristics of public buildings in the countries covered by the project, which will serve as a basis for the analyses connected with the *defining the cost optimal and low-risk technological "packages of measures" for the refurbishment of the public buildings towards nZEB.*

After taking consideration of the buildings characteristics that are important for their energy consumption, the ISO requirements and the experience of the project partners, the structure of the information has been presented in a series of tables:

- Building (Zone) geometry
- Building (Zone) properties
- Internal gains and operational schedule
- Holidays schedule
- Heating mode
- Mechanical ventilation system (heating mode)
- Domestic hot water system

- Cooling mode
- Cooling system
- Mechanical ventilation system (cooling mode)
- Appliances not influencing the thermal balance

Reference buildings, which represent the corresponding category/Subcategory, have been selected on the basis of the collected information and the classification of public buildings by categories, presented in D2.1.

The choice has been made taking into account the heated/conditioned areas and the specific energy consumption per unit of area.

Depending on the available information and the individual building performance, the choice the partners made was different: real or imaginary building, which performance reflects the character of the corresponding category.

Data gaps will be filled-in with default data.

Each country has applied the defined criteria in order to choose at least 2 reference buildings, for some of the partners their number is bigger – up to 4.

The most popular categories, for which reference buildings have been selected, are the offices (9) and the educational buildings (8).

The created reliable database of reference buildings, representing the specific features of the public building stock in the studied countries, after a simulation will allow to make a comparative analysis by countries, climate conditions and types of use.

Appendix - Country data

BULGARIA

The main conclusions of the analysis of the four selected representative building categories are as follows:

I. Building category: Residential

Subcategory: Student housing

- The reference building should have built-up area between 5000 and 10000 m^2,
- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1999,
- Occupancy schedule – 24 h/day 7 days/week,
- Technical systems: central heating with two options:
  a) based on light oil burning water heating boiler
  b) based on district heating

Table BG1: Residential, Student housing

Building category		**RESIDENTIAL**
Subcategory		**STUDENT HOUSING**
Conditioned area	m^2	8270 (Based on external dimensions)
Conditioned volume	m^3	22247 (net volume)
Climatic zone		Ref. number: 7 City: Sofia 1 Varna
Part 1: Building (Zone) geometry		
Walls, north	m^2	382,04
Walls, east	m^2	1019,93
Walls, south	m^2	358,49
Walls, west	m^2	1077,69
Windows, north	m^2	36,94
Windows, east	m^2	494,60
Windows, south	m^2	48,99
Windows, west	m^2	456,12
Roof	m^2	1628,37
Floor	m^2	1628,37
Part 2: Building (Zone) properties		

Uwalls	W/m^{2}K	Prior to investment 0,50	Requirement at 2014 0,35
ΔUtb	W/m^{2}K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^{2}K	Prior to investment 2,65	Requirement at 2014 1,7
fraction of the window frame area	%	Taken into account in Uwindows and g	
g(F)	-	0,58	
Uroof	W/m^{2}K	Prior to investment 0,3	Requirement at 2014 0,28
Ufloor	W/m^{2}K	Prior to investment 0,2	Requirement at 2014 0,2
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,63	
Infiltration, non occupancy	h^{-1}	0,63	
Thermal capacity	Wh/m^{2}K	45,83	

Part 3: Internal gains and operational schedule

Metabolic heat (occupants)	W/m²	5,5
Latent metabolic heat	W/m²	n/a
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Lighting for illumination	W/m²	3,2
Weekdays	h/day	6
Saturdays	h/day	6
Sundays	h/day	6
Lighting, emergency/controls	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	7,14
Weekdays	h/day	24
Saturdays	h/day	24

Sundays	h/day	24
Latent heat	W/m²	For cooling calculations
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	21	h/day	24
Saturdays	°C	21	h/day	24
Sundays	°C	21	h/day	24
Unoccupied period	°C	21		
Holidays	°C	21		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	97
Generation efficiency	%	100
Energy source (fuel, energy carrier)	-	District heating
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,25
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	1564
Temperature difference	°C	30
Distribution efficiency	%	93
Automatic control %	%	97
Generation efficiency %	%	100
Energy source (fuel, energy carrier)	-	District heating
Pumps, DHW system	W/m²	0,1

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	n/a
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	0
Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

II. Building category: Offices/Public administration

Subcategory: Central authorities

- The reference building should have built-up area less than 5000 m^2,
- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1999,
- Occupancy schedule – 8 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) based on light oil burning water heating boiler
  b) based on district heating

Table BG2: Office/public administration, Central authorities – Administrative buildings

Building category		**OFFICES/PUBLIC ADMINISTRATION**	
Subcategory		**Central authorities – Administrative Building**	
Conditioned area	m^2	1772 (external dimensions)	
Conditioned volume	m^3	4252 (net volume)	
Climatic zone		Ref. number: 7 City: Sofia 1 Varna	
Part 1: Building (Zone) geometry			
Walls, north	m^2	231,26	
Walls, east	m^2	273,96	
Walls, south	m^2	310,52	
Walls, south-west	m^2	60,88	
Walls, west	m^2	166,33	
Walls, north-west	m^2	47,0	
Windows, north	m^2	154,2	
Windows, east	m^2	48,7	
Windows, south	m^2	78,04	
Windows, west	m^2	28,27	
Windows, north-west	m^2	31,14	
Roof	m^2	526,83	
Floor	m^2	387,83	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,5	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,65	Requirement at 2014 1,7
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,56	
Uroof (to the external air)	W/m^2K	Prior to investment 0,3	Requirement at 2014 0,28
Ufloor (to the external air)	W/m^2K	Prior to investment	Requirement at 2014

		0,2	0,2
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,7	
Infiltration, non occupancy	h^{-1}	0,7	
Thermal capacity	Wh/m^2K	45,83	

Part 3: Internal gains and operational schedule

Metabolic heat (occupants)	W/m²	6,3
Latent metabolic heat	W/m²	0
Weekdays	h/day	9
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	4,1
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	8,8
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Latent heat	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
No. of holidays (excluding weekends)	3	0	1	0	3	0	0	0	3	0	1	3

Part 5: Heating mode

	Set-point	**Duration**

	temperature			
Weekdays	°C	20	h/day	8
Saturdays	°C	15	h/day	24
Sundays	°C	15	h/day	24
Unoccupied period	°C	15		
Holidays	°C	15		

Part 6: Heating system		
Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	97
Generation efficiency	%	89
Energy source (fuel, energy carrier)	-	Light oil burning water heating boiler
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,58
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C	25	h/day	8
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²			0,67	
Ventilation rate, non-occupancy, m³/hm²			0	
Heat recovery efficiency, %			n/a	
Emission efficiency, %			100	
Distribution efficiency, %			100	
Automatic control, %			97	
Generation efficiency, %			100	
Energy source (fuel, energy carrier)			Electricity	
Fans, occupancy period, W/m²			0,30	
Fans, non-occupancy period, W/m²			0	

Part 8: Domestic hot water systems		
Quantity	l/m²year	107
Temperature difference	°C	30
Distribution efficiency	%	95

Automatic control %	%	97
Generation efficiency %	%	89
Energy source (fuel, energy carrier)	-	Light oil burning water heating boiler
Pumps, DHW system	W/m²	0

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	25	h/day	9
Saturdays	°C	29	h/day	24
Sundays	°C	29	h/day	24
Unoccupied period	°C	29		
Holidays	°C	29		

Part 10: Cooling system

Emission efficiency	%	100
Distribution efficiency	%	100
Automatic control	%	97
Generation efficiency	%	250
Fans/pumps room units	W/m²	0,2
Pumps cooling system	W/m²	0,38

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C	20	h/day	9
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	0,67
Ventilation rate, non-occupancy, m³/hm²	0
Heat recovery efficiency, %	n/a
Night – cooling, m³/hm²	n/a
Free – cooling, m³/hm²	n/a
Emission efficiency,%	100
Distribution efficiency, %	100
Automatic control, %	97
Generation efficiency, %	250
Fans, occupancy period, W/m²	0,3

Fans, non-occupancy period, W/m²	0
Fans, night cooling, W/m²	n/a
Fans, free-cooling, W/m²	n/a

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	4,54 W/m²	h/day	24
Saturdays	4,54 W/m²	h/day	24
Sundays	4,54 W/m²	h/day	24

III. Building category: Educational buildings

Subcategory: Schools

- The reference building should have built-up area less than 5000 m^2,
- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1999,
- Occupancy schedule:
  a) 8 h/day 5 days/week,
  b) 12 h/day 5 days/week.
- Technical systems: central heating with two options:
  a) based on light oil burning water heating boiler
  b) based on district heating.

Table BG3: Educational buildings, Schools

Building category		**EDUCATIONAL BUILDINGS**
Subcategory		**School**
Conditioned area	m^2	3510 (external dimensions)
Conditioned volume	m^3	11583 (net volume)
Climatic zone		Ref.number: 7 City: Sofia 1 Varna
Part 1: Building (Zone) geometry		
Walls, north	m^2	537
Walls, east	m^2	70
Walls, south	m^2	1260
Walls, west	m^2	93
Windows, north	m^2	230
Windows, east	m^2	30
Windows, south	m^2	540

Windows, west	m^2	40	
Roof	m^2	1050	
Floor	m^2	1050	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,50	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,65	Requirement at 2014 1,7
fraction of the window frame area	%	taken into account in Uwindows and g	
g(F)	-	0,56	
Uroof (to external air)	W/m^2K	Prior to investment 0,3	Requirement at 2014 0,28
Ufloor (to external air)	W/m^2K	Prior to investment 0,2	Requirement at 2014 0,2
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,7	
Infiltration, non occupancy	h^{-1}	0,7	
Thermal capacity	Wh/m^2K	45,83	
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	6,9	
Latent metabolic heat	W/m²	n/a	
Weekdays	h/day	12	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²	1,7	
Weekdays	h/day	4	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting, emergency/controls	W/m²	0	
Weekdays	h/day		
Saturdays	h/day		

Sundays	h/day	
Appliances	W/m²	0,6
Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	3	0	1	9	3	10	23	22	11	0	1	7

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	12
Saturdays	°C	15	h/day	24
Sundays	°C	15	h/day	24
Unoccupied period	°C	15		
Holidays	°C	15		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	97
Generation efficiency	%	89
Energy source (fuel, energy carrier)	-	Light oil burning water heating boiler
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	0,2
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply	Duration

	temperature			
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems		
Quantity	l/m²year	11
Temperature difference	°C	30
Distribution efficiency	%	95
Automatic control %	%	97
Generation efficiency %	%	89
Energy source (fuel, energy carrier)	-	Light oil burning water heating boiler
Pumps, DHW system	W/m²	0,15

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	n/a
Distribution efficiency	%	
Automatic control	%	

Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	40 W/m²	h/day	8
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

IV. Building category: Health-care facilities

Subcategory: Hospitals

- The reference building should have built-up area less than 5000 m2,
- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1999,
- Occupancy schedule: 24 h/day 7 days/week,
- Technical systems: central heating with two options:

a) based on light oil burning water heating boiler
b) based on district heating

Table BG4: Health-care facilities, Hospitals

Building category		**HEALTH-CARE FACILITIES**	
Subcategory		**Hospital**	
Conditioned area	m^2	2546 (external dimensions)	
Conditioned volume	m^3	8106 (net volume)	
Climatic zone		Ref. number: 7 City: Sofia 1 Varna	
Part 1: Building (Zone) geometry			
Walls, north	m^2	764,26	
Walls, east	m^2	250,45	
Walls, south	m^2	560,47	
Walls, west	m^2	251	
Windows, north	m^2	207,76	
Windows, east	m^2	37,69	
Windows, south	m^2	367,55	
Windows, west	m^2	43,42	
Roof	m^2	1067	
Floor	m^2	1067	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,50	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,65	Requirement at 2014 1,7
fraction of the window frame area	%	taken into account in Uwindows and g	
g(F)	-	0,56	
Uroof (to external air)	W/m^2K	Prior to investment 0,30	Requirement at 2014 0,28
Ufloor (to external air)	W/m^2K	Prior to investment 0,2	Requirement at 2014 0,2

ε	-	0,9
α	-	0,6
Infiltration, occupancy period	h^{-1}	0,7
Infiltration, non occupancy	h^{-1}	0,7
Thermal capacity	Wh/m^2K	45,83

Part 3: Internal gains and operational schedule

Metabolic heat (occupants)	W/m²	5,4
Latent metabolic heat	W/m²	0
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Lighting for illumination	W/m²	4,1
Weekdays	h/day	8,5
Saturdays	h/day	8,5
Sundays	h/day	8,5
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	4
Weekdays	h/day	7,5
Saturdays	h/day	7,5
Sundays	h/day	7,5
Latent heat	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature	**Duration**

Weekdays	°C	21	h/day	24
Saturdays	°C	21	h/day	24
Sundays	°C	21	h/day	24
Unoccupied period	°C	21		
Holidays	°C	21		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	97
Generation efficiency	%	89
Energy source (fuel, energy carrier)	-	Light oil burning water heating boiler
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	2
Pumps pre-heating ventilation	W/m²	0,53

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		**Duration**	
Weekdays	°C	21	h/day	7,5
Saturdays	°C	21	h/day	7,5
Sundays	°C	21	h/day	7,5

Ventilation rate, occupancy period, m³/hm²	2,5
Ventilation rate, non-occupancy, m³/hm²	0
Heat recovery efficiency, %	n/a
Emission efficiency, %	100
Distribution efficiency, %	95
Automatic control, %	97
Generation efficiency, %	100
Energy source (fuel, energy carrier)	Electricity
Fans, occupancy period, W/m²	2,2
Fans, non-occupancy period, W/m²	0

Part 8: Domestic hot water systems

Quantity	l/m²year	1702
Temperature difference	°C	30
Distribution efficiency	%	95

Automatic control %	%	97
Generation efficiency %	%	89
Energy source (fuel, energy carrier)	-	Light oil burning water heating boiler
Pumps, DHW system	W/m²	0,15

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	n/a
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				

Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	7,5 W/m²	h/day	8
Saturdays	7,5 W/m²	h/day	8
Sundays	7,5 W/m²	h/day	8

CROATIA

I. Building category: Administrative buildings

Subcategory: Offices

Table HR1: Reference office building for continental climate

Building category		**Office buildings**
Subcategory		
Conditioned area	m^2	2677,37
Conditioned volume	m^3	8032,11
Climatic zone		Zagreb Maksimir
Part 1: Building (Zone) geometry		
Walls, north	m^2	3869,60
Walls, east	m^2	-
Walls, south	m^2	-
Walls, west	m^2	-
Windows, north	m^2	352,80
Windows, east	m^2	118,80
Windows, south	m^2	352,80
Windows, west	m^2	118,80
Roof	m^2	1024,00
Floor	m^2	1024,00
Part 2: Building (Zone) properties		
Uwalls	W/m^2K	Prior to investment 0,56	Requirement at 2014 0,45

ΔUtb	W/m^{2}K	0,10	
b(ground)	-	n/a – seasonal variation of ground temperature used in calculation	
b(un-conditioned space)	-	1	
b(adjacent sunspace)	-	1	
b(adjacent building)	m^2	1	
Uwindows	W/m^{2}K	Prior to investment 2,75	Requirement at 2014 1,80
fraction of the window frame area	%	0,30	
g(F)	-	0,60	
Uroof	W/m^{2}K	Prior to investment 0,50	Requirement at 2014 0,30
Ufloor	W/m^{2}K	Prior to investment 0,52	Requirement at 2014 0,30
ε	-	Emissivity for external walls (depending on type of materials and surface) n/a	
α	-	Solar absorption for external walls (depending on type of materials and surface) n/a	
Infiltration, occupancy period	h^{-1}	0,70	
Infiltration, non occupancy	h^{-1}	0,20	
Thermal capacity	Wh/m^{2}K	696 MJ/K	
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	Average metabolic heat during the operation period 6	
Latent metabolic heat	W/m²	For cooling calculations n/a	
Weekdays	h/day	13	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²	Average lighting power during the operation period 9,72	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		

Lighting, emergency/controls	W/m²	Average lighting power during the operation period n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	Average simultaneous power from appliances during the operation period n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Latent heat	W/m²	For cooling calculations n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	13 h/day	h/day with set-point temperature
Saturdays	°C	20	0 h/day	
Sundays	°C	20	0 h/day	
Unoccupied period	°C	15		
Holidays	°C	15		

Part 6: Heating system

Emission efficiency	%	79,37
Distribution efficiency	%	81,49
Automatic control	%	80
Generation efficiency	%	82,89

Energy source (fuel, energy carrier)	-	Natural gas
Fans/pumps room units	W/m²	n/a
Pumps heating system	W/m²	n/a
Pumps pre-heating ventilation	W/m²	n/a

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	26	24 h/day	h/day with set-point temperature
Saturdays	°C	26	0 h/day	

Sundays	°C	26	0 h/day	
Unoccupied period	°C	28		
Holidays	°C	28		

Part 10: Cooling system

Emission efficiency	%	88,49
Distribution efficiency	%	100
Automatic control	%	0
Generation efficiency	%	100
Fans/pumps room units	W/m²	n/a
Pumps cooling system	W/m²	n/a

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	

Sundays	W/m²	h/day	

II. Building category: Healthcare facilities

Subcategory:

Table HR2: Reference health care building for continental climate

Building category		**Healthcare facilities**	
Subcategory			
Conditioned area	m^2	2786,4	
Conditioned volume	m^3	9473,76	
Climatic zone		Zagreb Maksimir	
Part 1: Building (Zone) geometry			
Walls, north	m^2	1025,61	
Walls, east	m^2	-	
Walls, south	m^2	-	
Walls, west	m^2	-	
Windows, north	m^2	194	
Windows, east	m^2	52	
Windows, south	m^2	204	
Windows, west	m^2	60	
Roof	m^2	2048,00	
Floor	m^2	1591,00	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,99	Requirement at 2014 0,45
ΔUtb	W/m^2K	0,10	
b(ground)	-	n/a – seasonal variation of ground temperature used in calculation	
b(un-conditioned space)	-	1	
b(adjacent sunspace)	-	1	
b(adjacent building)	m^2	1	
Uwindows	W/m^2K	Prior to investment 2,90	Requirement at 2014 1,80
fraction of the window frame area	%	0,30	
g(F)	-	0,60	
Uroof	W/m^2K	Prior to investment	Requirement at 2014

		0,50	0,30
Ufloor	W/m^{2}K	Prior to investment 0,54	Requirement at 2014 0,30
ε	-	Emissivity for external walls (depending on type of materials and surface) n/a	
α	-	Solar absorption for external walls (depending on type of materials and surface) n/a	
Infiltration, occupancy period	h^{-1}	1,00 (average)	
Infiltration, non occupancy	h^{-1}	0,20	
Thermal capacity	Wh/m^{2}K	724,46 MJ/K	
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	Average metabolic heat during the operation period 6	
Latent metabolic heat	W/m²	For cooling calculations n/a	
Weekdays	h/day	24	
Saturdays	h/day	24	
Sundays	h/day	24	
Lighting for illumination	W/m²	Average lighting power during the operation period 16,24	
Weekdays	h/day	24	
Saturdays	h/day	24	
Sundays	h/day	24	
Lighting, emergency/controls	W/m²	Average lighting power during the operation period n/a	
Weekdays	h/day	24	
Saturdays	h/day	24	
Sundays	h/day	24	
Appliances	W/m²	Average simultaneous power from appliances during the operation period n/a	
Weekdays	h/day	24	
Saturdays	h/day	24	
Sundays	h/day	24	

Latent heat	W/m²	For cooling calculations n/a
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	22	24 h/day	h/day with set-point temperature
Saturdays	°C	22	24 h/day	
Sundays	°C	22	24 h/day	
Unoccupied period	°C	15		
Holidays	°C	15		

Part 6: Heating system

Emission efficiency	%	83,41
Distribution efficiency	%	90,28
Automatic control	%	100
Generation efficiency	%	94,31
Energy source (fuel, energy carrier)	-	Natural gas
Fans/pumps room units	W/m²	n/a
Pumps heating system	W/m²	n/a
Pumps pre-heating ventilation	W/m²	n/a

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C	θe	h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C	θe	h/day	
Sundays	°C	θe	h/day	

Ventilation rate, occupancy period, m³/hm²	1500
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	0,80
Emission efficiency, %	-
Distribution efficiency, %	-
Automatic control, %	-
Generation efficiency, %	-
Energy source (fuel, energy carrier)	Electric energy
Fans, occupancy period, W/m²	n/a
Fans, non-occupancy period, W/m²	n/a

Part 8: Domestic hot water systems

Quantity	l/m²year	392
Temperature difference	°C	45
Distribution efficiency	%	59,47
Automatic control %	%	-
Generation efficiency %	%	94,31
Energy source (fuel, energy carrier)	-	Natural gas
Pumps, DHW system	W/m²	-

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C	26	24 h/day	h/day with set-point temperature
Saturdays	°C	26	0 h/day	
Sundays	°C	26	0 h/day	
Unoccupied period	°C	28		
Holidays	°C	28		

Part 10: Cooling system

Emission efficiency	%	89,70
Distribution efficiency	%	95,92
Automatic control	%	0
Generation efficiency	%	100
Fans/pumps room units	W/m²	n/a
Pumps cooling system	W/m²	n/a

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C	θe	h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C	θe	h/day	
Sundays	°C	θe	h/day	
Ventilation rate, occupancy period, m³/hm²			1500	
Ventilation rate, non-occupancy, m³/hm²			0	
Heat recovery efficiency, %			80	
Night – cooling, m³/hm²			0	
Free – cooling, m³/hm²			0	
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

GREECE

I. Building category: Offices/Public administration

Subcategory: Central authorities

- The reference building should have built-up area between 1000 m2 and 1500 m2 for municipal buildings, and 10000 m2 for central administration buildings,
- Construction materials – concrete +masonry; thermal properties of the building envelope – before the 'Thermal Insulation Regulation' of 1979,
- Occupancy schedule – 10 h/day 5 days/week,
- Technical systems: central heating with oil burning water heating boiler

Table GR1: Offices/public administration, Central authorities – Administrative buildings

Building category		OFFICES/PUBLIC ADMINISTRATION	
Subcategory		Central authorities – Administrative Building	
Conditioned area	m^2	5901 (external dimensions)	
Conditioned volume	m^3	20228 (net volume)	
Climatic zone		Ref. number: City: Athens, (climatic zone B)	
Part 1: Building (Zone) geometry			
Walls, north	m^2	640	
Walls, east	m^2	1134	
Walls, south	m^2	1327	
Walls, south-west	m^2	-	
Walls, west	m^2	945	
Walls, north-west	m^2	-	
Windows, north	m^2	170	
Windows, east	m^2	189	
Windows, south	m^2	367	
Windows, west	m^2	110	
Windows, north-west	m^2	-	
Roof	m^2	887,63	
Floor	m^2	887,63	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 2,2	Requirement at 2014 0,50
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 5,70	Requirement at 2014 3,0
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,85	
Uroof (to the external air)	W/m^2K	Prior to investment 3,05	Requirement at 2014 0,45
Ufloor (to the external air)	W/m^2K	Prior to investment 3,1	Requirement at 2014 0,50
ε	-	0,8	

α	-	0,4
Infiltration, occupancy period	h^{-1}	0,44
Infiltration, non occupancy	h^{-1}	n/a
Thermal capacity	Wh/m^2K	72,23

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	8,0
Latent metabolic heat	W/m²	0
Weekdays	h/day	10
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	16,0
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	15,0
Weekdays	h/day	10
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	2	2	1	1	0	1	0	1	0	2

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	10

Saturdays	°C	off	h/day	
Sundays	°C	off	h/day	
Unoccupied period	°C	off		
Holidays	°C	off		

Part 6: Heating system		
Emission efficiency	%	93
Distribution efficiency	%	95
Automatic control	%	n/a
Generation efficiency	%	89
Energy source (fuel, energy carrier)	-	Oil burning water heating boiler
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	1,05 kW
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)				
	Supply temperature		Duration	
Weekdays	°C	20	h/day	10
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	3,00
Ventilation rate, non-occupancy, m³/hm²	0
Heat recovery efficiency, %	n/a
Emission efficiency, %	100
Distribution efficiency, %	100
Automatic control, %	n/a
Generation efficiency, %	2,20 (COP)
Energy source (fuel, energy carrier)	Electricity
Fans, occupancy period, W/m²	5
Fans, non-occupancy period, W/m²	0

Part 8: Domestic hot water systems		
Quantity	l/m²year	n/a
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	

Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	26	h/day	10
Saturdays	°C	off	h/day	
Sundays	°C	off	h/day	
Unoccupied period	°C	off		
Holidays	°C	off		

Part 10: Cooling system

Emission efficiency	%	93
Distribution efficiency	%	100
Automatic control	%	n/a
Generation efficiency	%	1,50 (COP)
Fans/pumps room units	W/m²	n/a
Pumps cooling system	W/m²	n/a

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C	n/a	h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	n/a
Ventilation rate, non-occupancy, m³/hm²	0
Heat recovery efficiency, %	n/a
Night – cooling, m³/hm²	n/a
Free – cooling, m³/hm²	n/a
Emission efficiency,%	n/a
Distribution efficiency, %	n/a
Automatic control, %	n/a
Generation efficiency, %	n/a
Fans, occupancy period, W/m²	n/a
Fans, non-occupancy period, W/m²	n/a
Fans, night cooling, W/m²	n/a
Fans, free-cooling, W/m²	n/a

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	4,5 W/m²	h/day	24
Saturdays	4,5 W/m²	h/day	24
Sundays	4,5 W/m²	h/day	24

II. Building category: Educational buildings

Subcategory: Schools

- The reference building should have built-up area less than 2000 m2,
- Construction materials – concrete+masonry; thermal properties of the building envelope – before the 'Thermal Insulation Regulation' of 1979,
- Occupancy schedule - 8 h/day 5 days/week, 9 months (September – May) for primary and secondary schools
- Technical systems: central heating with oil burning water heating boiler

Table GR2: Educational buildings, Schools

Building category		EDUCATIONAL BUILDINGS	
Subcategory		**School**	
Conditioned area	m^2	1785,8 (external dimensions)	
Conditioned volume	m^3	6247,6 (net volume)	
Climatic zone		Ref.number: 1 City: Athens (climatic zone B)	
Part 1: Building (Zone) geometry			
Walls, northeast	m^2	203	
Walls, southeast	m^2	165	
Walls, southwest	m^2	212	
Walls, northwest	m^2	161	
Windows, northeast	m^2	130	
Windows, southeast	m^2	19	
Windows, southwest	m^2	136	
Windows, northwest	m^2	25	
Roof	m^2	591	
Floor	m^2	591	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,81	Requirement at 2014 0,50

ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 5,70	Requirement at 2014 3,0
fraction of the window frame area	%	taken into account in Uwindows and g	
g(F)	-	0,85	
Uroof (to external air)	W/m^2K	Prior to investment 4,18	Requirement at 2014 0,45
Ufloor (to external air)	W/m^2K	Prior to investment 5,72	Requirement at 2014 0,50
ε	-	0,8	
α	-	0,4	
Infiltration, occupancy period	h^{-1}	0,43	
Infiltration, non occupancy	h^{-1}	n/a	
Thermal capacity	Wh/m^2K	72,23	
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	40,0	
Latent metabolic heat	W/m²	n/a	
Weekdays	h/day	8	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²	9,6	
Weekdays	h/day	8	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting, emergency/controls	W/m²	0	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m²	5	
Weekdays	h/day	8	
Saturdays	h/day	0	
Sundays	h/day	0	
Latent heat	W/m²	n/a	

Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	5	0	2	10	2	7	23	21	8	1	1	6

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8
Saturdays	°C	off	h/day	
Sundays	°C	off	h/day	
Unoccupied period	°C	off		
Holidays	°C	off		

Part 6: Heating system

Emission efficiency	%	93
Distribution efficiency	%	93,5
Automatic control	%	n/a
Generation efficiency	%	89
Energy source (fuel, energy carrier)	-	Oil burning water heating boiler
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	5
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				

Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	n/a
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	26	h/day	8
Saturdays	°C	off	h/day	
Sundays	°C	off	h/day	
Unoccupied period	°C	off		
Holidays	°C	off		

Part 10: Cooling system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	n/a
Generation efficiency	%	2,80 (EER)
Fans/pumps room units	W/m²	n/a
Pumps cooling system	W/m²	n/a

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a

Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				
Part 12: Appliances not influencing the thermal balance				
	Average simultaneous power		Duration	
Weekdays	0,75 W/m²		h/day	24
Saturdays	0,75 W/m²		h/day	24
Sundays	0,75 W/m²		h/day	24

HUNGARY

I. Building category: Health-care facilities

Subcategory: Other institutional care buildings

- The reference building should have built-up area less than 5000 m2,
- Construction materials – precast reinforced concrete unit
- Occupancy schedule: 12 h/day 5 days/week,
- Technical systems: central heating based on district heating

Table HU1: Health-care facilities, Other institutional care buildings

Building category		**HEALTH-CARE FACILITIES**
Subcategory		**Other institutional care buildings**
Conditioned area	m^2	3560
Conditioned volume	m^3	9968
Climatic zone		City: Győr

Part 1: Building (Zone) geometry		
Walls, north-east	m^2	210,6
Walls, south-east	m^2	477,5
Walls, south-west	m^2	210,6
Walls, north-west	m^2	479,2
Windows, north-east	m^2	149,9
Windows, south-east	m^2	157,6
Windows, south-west	m^2	0
Windows, north-west	m^2	155,8
Roof	m^2	1129
Floor	m^2	1209,6

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,7	Requirement at 2014 0,45
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 1,2	Requirement at 2014 1,6
fraction of the window frame area	%	Taken into account in Uwindows	
g(F)	-	0,783	
Uroof	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 0,6	Requirement at 2014 0,5
ε	-	0,75	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,5	
Infiltration, non occupancy	h^{-1}	0,5	
Thermal capacity	Wh/m^2K	113,8	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	5
Latent metabolic heat	W/m²	n/a

Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	5,5
Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	11
Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	1	2	0	0	1	0	1	0	3

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	22	h/day	12
Saturdays	°C	19	h/day	24
Sundays	°C	19	h/day	24
Unoccupied period	°C	19		
Holidays	°C	18		

Part 6: Heating system

Emission efficiency	%	100

Distribution efficiency	%	97
Automatic control	%	92
Generation efficiency	%	99
Energy source (fuel, energy carrier)	-	District heating
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0.05
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	1910
Temperature difference	°C	35
Distribution efficiency	%	88
Automatic control %	%	93
Generation efficiency %	%	88
Energy source (fuel, energy carrier)	-	District heating
Pumps, DHW system	W/m²	0.03

Part 9: Cooling mode

	Set-point temperature	**Duration**

Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	

		Duration	
Weekdays	W/m²	h/day	0
Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

II. Building category: Offices/Public administration

Subcategory: Central authorities

- The reference building should have built-up area less than 5000 m2,
- Construction materials – masonry,
- Occupancy schedule – 8 h/day 5 days/week,
- Technical systems:
- central heating based on gas burning water heating boiler
- DHW: electricity based water heating boiler

Table HU2: Office/public administration, Central authorities – Administrative buildings

Building category		**OFFICES/PUBLIC ADMINISTRATION**	
Subcategory		**Central authorities – Administrative Building**	
Conditioned area	m^2	1559	
Conditioned volume	m^3	4677	
Climatic zone		City: Nagyatád	
Part 1: Building (Zone) geometry			
Walls, north	m^2	224,9	
Walls, east	m^2	124,7	
Walls, south	m^2	199,1	
Walls, west	m^2	123,5	
Windows, north	m^2	153,1	
Windows, east	m^2	117,3	
Windows, south	m^2	199,9	
Windows, west	m^2	119,5	
Roof	m2	835	
Floor	m2	835	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,84	Requirement at 2014 0,45
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	

b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 3,2	Requirement at 2014 1,6
fraction of the window frame area	%	Taken into account in Uwindows	
g(F)	-	0,783	
Uroof	W/m^2K	Prior to investment 3,17	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 2,71	Requirement at 2014 0,5
ε	-	0,75	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,8	
Infiltration, non occupancy	h^{-1}	0,8	
Thermal capacity	Wh/m^2K	113,8	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	7
Latent metabolic heat	W/m²	n/a
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	5,5
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	9
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	

Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	1	2	0	0	1	0	1	0	3

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	21	h/day	8
Saturdays	°C	18	h/day	24
Sundays	°C	18	h/day	24
Unoccupied period	°C	18		
Holidays	°C	18		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	99
Automatic control	%	96,1
Generation efficiency	%	87
Energy source (fuel, energy carrier)	-	gas
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0.08
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				

Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	220
Temperature difference	°C	35
Distribution efficiency	%	100
Automatic control %	%	94
Generation efficiency %	%	100
Energy source (fuel, energy carrier)	-	Electricity
Pumps, DHW system	W/m²	0

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	n/a
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a

Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	0
Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

III. Building category: Offices/Public administration

Subcategory: Office building

- The reference building should have built-up area less than 5000 m^2,
- Construction materials – masonry
- Occupancy schedule – 8 h/day 5 days/week,
- Technical systems: central heating based on district heating

Table HU3: Office/public administration, Office buildings

Building category		**OFFICES/PUBLIC ADMINISTRATION**
Subcategory		**Office Building**
Conditioned area	m^2	2510,4
Conditioned volume	m^3	6940,5
Climatic zone		City: Budapest

Part 1: Building (Zone) geometry		
Walls, north	m^2	116,8
Walls, east	m^2	285,7
Walls, south	m^2	156,9
Walls, west	m^2	304,3
Windows, north	m^2	64,8
Windows, east	m^2	313,8
Windows, south	m^2	24,7
Windows, west	m^2	295,2
Roof	m^2	478,1
Floor	m^2	500,7

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 2,1	Requirement at 2014 0,45
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,31	Requirement at 2014 1,6
fraction of the window frame area	%		
g(F)	-	0,783	
Uroof	W/m^2K	Prior to investment 1,1	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 0,6	Requirement at 2014 0,5
ε	-	0,75	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,8	
Infiltration, non occupancy	h^{-1}	0,8	
Thermal capacity	Wh/m^2K	152,4	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	7
Latent metabolic heat	W/m²	n/a

Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	5,5
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	9
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	1	2	0	0	1	0	1	0	3

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8
Saturdays	°C	18	h/day	24
Sundays	°C	18	h/day	24
Unoccupied period	°C	18		
Holidays	°C	18		

Part 6: Heating system

Emission efficiency	%	100

Distribution efficiency	%	98
Automatic control	%	99
Generation efficiency	%	100
Energy source (fuel, energy carrier)	-	District heating
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,07
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems

Quantity	l/m²year	220
Temperature difference	°C	35
Distribution efficiency	%	88
Automatic control %	%	96
Generation efficiency %	%	88
Energy source (fuel, energy carrier)	-	District heating
Pumps, DHW system	W/m²	0.05

Part 9: Cooling mode

	Set-point temperature	**Duration**

Weekdays	°C	26	h/day	8
Saturdays	°C	30	h/day	24
Sundays	°C	30	h/day	24
Unoccupied period	°C	30		
Holidays	°C	30		

Part 10: Cooling system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	90
Generation efficiency	%	300
Fans/pumps room units	W/m²	2,5
Pumps cooling system	W/m²	0,3

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	0

Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

IV. Building category: Educational buildings

Subcategory: Kindergartens

- The reference building should have built-up area less than 5000 m^2,
- Construction materials – precast reinforced concrete unit
- Occupancy schedule: 8 h/day 5 days/week,
- Technical systems:
- central heating based on gas burning water heating boiler
- DHW based on electricity.

Table HU4: Educational buildings, Kindergartens

Building category		**EDUCATIONAL BUILDINGS**	
Subcategory		**Kindergartens**	
Conditioned area	m^2	572,7	
Conditioned volume	m^3	1718	
Climatic zone		City: Budapest	
Part 1: Building (Zone) geometry			
Walls, north	m^2	131,4	
Walls, east	m^2	68,8	
Walls, south	m^2	0,6	
Walls, west	m^2	18,9	
Windows, north	m^2	94	
Windows, east	m^2	11,4	
Windows, south	m^2	93,9	
Windows, west	m^2	0	
Roof	m^2	570,7	
Floor	m^2	572,7	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,44	Requirement at 2014 0,45
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		

b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,6	Requirement at 2014 1,6
fraction of the window frame area	%	Taken into account in Uwindows and g	
g(F)	-	0,783	
Uroof	W/m^2K	Prior to investment 1,43	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 1,07	Requirement at 2014 0,5
ε	-	0,75	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,9	
Infiltration, non occupancy	h^{-1}	0,9	
Thermal capacity	Wh/m^2K	117,6	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	9
Latent metabolic heat	W/m²	n/a
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	3
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	6
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	6	2	7	23	21	0	1	4	5

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	22	h/day	10
Saturdays	°C	19	h/day	24
Sundays	°C	19	h/day	24
Unoccupied period	°C	19		
Holidays	°C	18		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	97
Automatic control	%	95
Generation efficiency	%	99
Energy source (fuel, energy carrier)	-	gas
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,07
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				

Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems		
Quantity	l/m²year	170
Temperature difference	°C	35
Distribution efficiency	%	90
Automatic control %	%	100
Generation efficiency %	%	100
Energy source (fuel, energy carrier)	-	Electricity
Pumps, DHW system	W/m²	0

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	0
Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

V. Building category: Educational buildings

Subcategory: Schools

- The reference building should have built-up area between 5000 and 10000 m^2,
- Construction materials – precast reinforced concrete unit
- Occupancy schedule: 8 h/day 5 days/week,
- Technical systems: central heating based on district heating

Table HU5: Educational buildings, Schools

Building category		**EDUCATIONAL BUILDINGS**
Subcategory		**School**
Conditioned area	m^2	5212,6
Conditioned volume	m^3	17466,7
Climatic zone		City: Budapest
Part 1: Building (Zone) geometry		
Walls, north	m^2	480,8

Walls, east	m^2	532
Walls, south	m^2	516,7
Walls, west	m^2	515
Windows, north	m^2	354
Windows, east	m^2	570,9
Windows, south	m^2	291,3
Windows, west	m^2	595,5
Roof	m^2	3101,2
Floor	m^2	2424,4

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 2,14	Requirement at 2014 0,45
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 3,2	Requirement at 2014 1,6
fraction of the window frame area	%	Taken into account in Uwindows and g	
g(F)	-	0,783	
Uroof	W/m^2K	Prior to investment 0,7	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 0,6	Requirement at 2014 0,5
ε	-	0,75	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	2,5	
Infiltration, non occupancy	h^{-1}	0,3	
Thermal capacity	Wh/m^2K	117,6	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	9
Latent metabolic heat	W/m²	n/a
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0

Lighting for illumination	W/m²	6
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	6
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	6	2	7	23	21	0	1	4	5

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8
Saturdays	°C	18	h/day	24
Sundays	°C	18	h/day	24
Unoccupied period	°C	18		
Holidays	°C	18		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	99
Automatic control	%	93
Generation efficiency	%	99

Energy source (fuel, energy carrier)	-	District heating
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,07
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	170
Temperature difference	°C	35
Distribution efficiency	%	87
Automatic control %	%	97
Generation efficiency %	%	85
Energy source (fuel, energy carrier)	-	District heating
Pumps, DHW system	W/m²	0.03

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	0
Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

VI. Building category: Residential

Subcategory: Student housing

- The reference building should have built-up area between 5000 and 10000 m2,
- Construction materials – precast reinforced concrete unit,
- Occupancy schedule – 24 h/day 7 days/week,
- Technical systems: central heating based on gas burning water heating boiler

Table HU6: Residential, Student housing

Building category		**RESIDENTIAL**
Subcategory		**STUDENT HOUSING**
Conditioned area	m^2	8311 (Based on external dimensions)
Conditioned volume	m^3	22509 (net volume)
Climatic zone		City: Budapest
Part 1: Building (Zone) geometry		
Walls, north-east	m^2	574,8
Walls, south-east	m^2	441,7
Walls, south-west	m^2	574,9
Walls, north-west	m^2	531,3
Windows, north-east	m^2	580,7
Windows, south-east	m^2	71,5
Windows, south-west	m^2	559,3
Windows, north-west	m^2	43,5
Roof	m^2	1321,8
Floor	m^2	1321,8

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,12	Requirement at 2014 0,45
ΔUtb	W/m^2K	Add on to U-wall to account for the effect of thermal bridges	
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 1,2	Requirement at 2014 1,6
fraction of the window frame area	%	Taken into account in Uwindows	

g(F)	-	0,783	
Uroof	W/m^{2}K	Prior to investment 0,53	Requirement at 2014 0,25
Ufloor	W/m^{2}K	Prior to investment 1,52	Requirement at 2014 0,5
ε	-	0,75	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	1	
Infiltration, non occupancy	h^{-1}	1	
Thermal capacity	Wh/m^{2}K	88,7	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	5,5
Latent metabolic heat	W/m²	n/a
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Lighting for illumination	W/m²	5
Weekdays	h/day	6
Saturdays	h/day	6
Sundays	h/day	6
Lighting, emergency/controls	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	8
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Latent heat	W/m²	n/a
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays	0	0	0	0	0	0	0	0	0	0	0	0

(excluding weekends)												

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	24
Saturdays	°C	20	h/day	24
Sundays	°C	20	h/day	24
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95,6
Automatic control	%	88,2
Generation efficiency	%	92,6
Energy source (fuel, energy carrier)	-	gas
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,04
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				

Fans, non-occupancy period, W/m²		

Part 8: Domestic hot water systems		
Quantity	l/m²year	740
Temperature difference	°C	35
Distribution efficiency	%	88
Automatic control %	%	93
Generation efficiency %	%	90,9
Energy source (fuel, energy carrier)	-	gas
Pumps, DHW system	W/m²	0,05

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	n/a
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				

Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	0
Saturdays	W/m²	h/day	0
Sundays	W/m²	h/day	0

ITALY

Definition of data

A second list of indicators has now to be considered:

Table IT 1 – Building general and dimensional data list

Characteristic	Symbol
Climatic zone	-
Period of construction	-
Total gross floor area [m^2]	A
Total net floor area [m^2]	A_n
Footprint [m^2]	-
Envelope surface [m^2]	S_e
Window surface [m^2]	S_w
Gross volume [m^3]	V
Net volume [m^3]	V_n
Number of floors	-
Medium height of floor [m]	h
Compactness ratio [m^{-1}]	S_e/V
Window/Envelope surface ratio	S_w/S_e
Window/Floor surface ratio	S_w/A_n

Because of its geographical characteristics, Italy is subdivided into six climatic zones according to the heating degree days. For different climatic zones also the building services and the referred energy consumption are different. The present work is focused on the climatic zone E, characterized by 2101-3000 heating degree days, because of its highest amount of public buildings, as shown in Figure IT 1 for two of the three building categories defined. Data refers to climatic zones E and F together, but Figure IT 2 highlights the climatic zone F corresponds to a slight portion of the country, often situated in mountains, in which the public building density is poor and thus not representative of the whole nation.

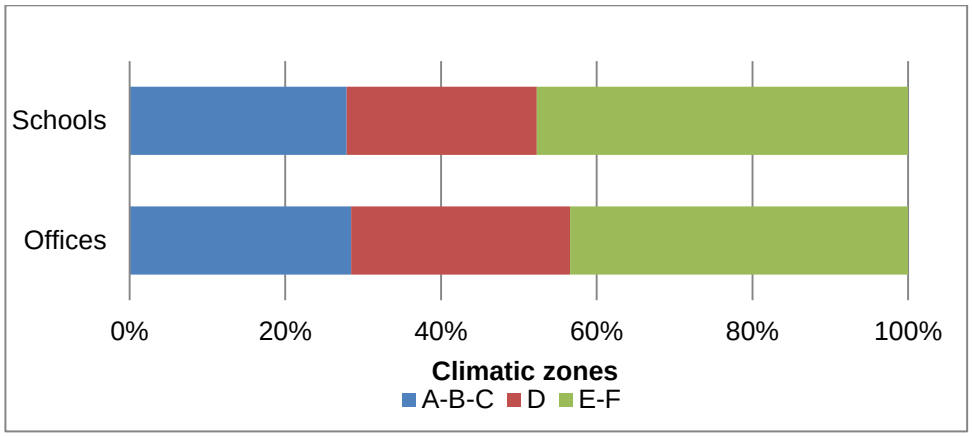

Figure IT 1 – Public building distribution for Italian climatic zone

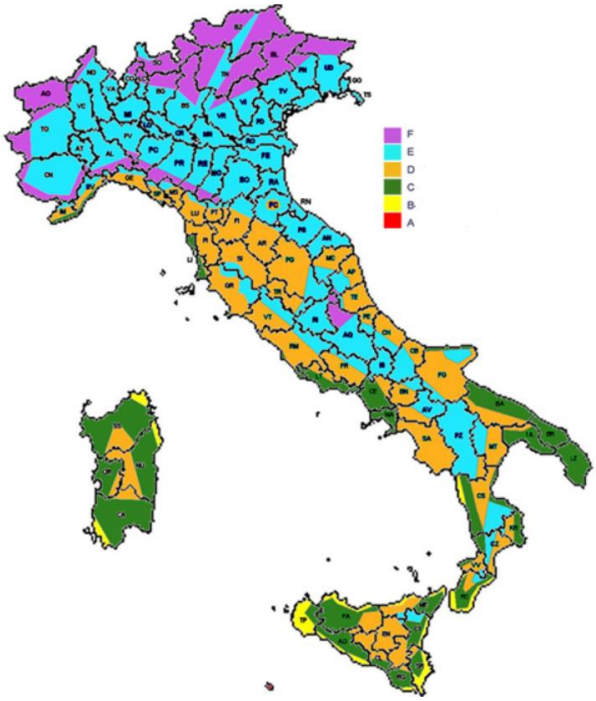

Figure IT 2 - Subdivision of Italy in climatic zones according to heating degree days

The period of construction is necessary in order to correctly define the building systems and the technological systems of the building stock. Concerning the period of construction for climatic zone E, the collected data referred to offices and residential buildings are shown in Figure IT 3, while for schools the subdivision in time steps is articulated in Figure IT 4.

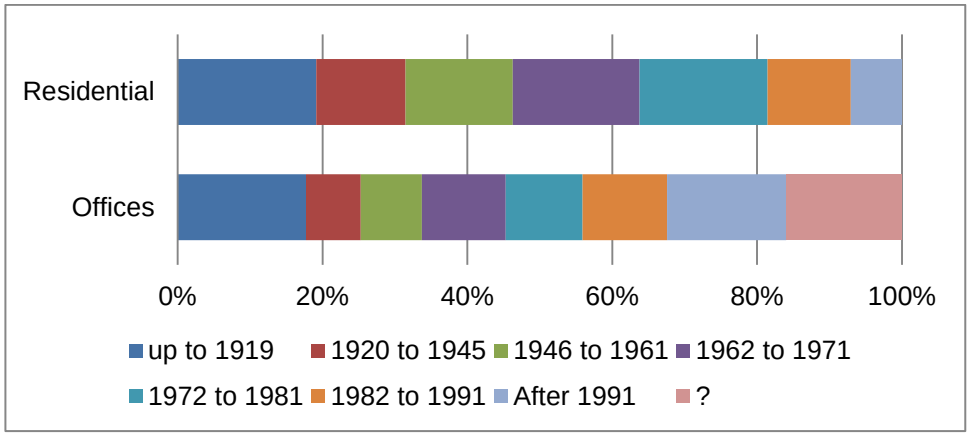

Figure IT 3 – Residential and office building stock period of construction in climatic zone E

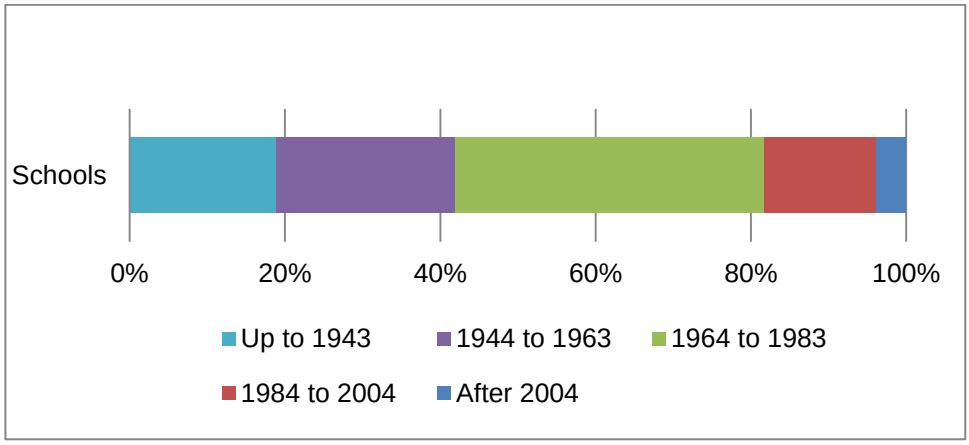

Figure IT 4 – Schools building stock period of construction in climatic zone E

The Italian study will be focused on two periods of construction for each category; the chosen period will be the most representative in terms of consistency of the building stock for each category. Thus:

- years up to 1919 will be considered for both residential buildings and offices;
- offices after 1991 reach the 16,4%, while the three periods in between 1962 and 1991 obtain a value around 11%;
- the two periods in between 1962 and 1981 show the 18% of residential buildings;
- the 40% of the building stock for schools is built in the period 1964-1983, while another 23% in between 1944 and 1963.

According to what mentioned before, the reference building are thus chosen as shown in Table IT 2.

Table IT 2 - Italian public building stock definition through indicators

Building category	CLIMATIC ZONE	PERIOD OF CONSTRUCTION	
Residential (Social housing)	E	Up to 1919	1962 to 1971 1972 to 1981
Offices (Public admin.) (Local authorities)	E	Up to 1919	After 1991
Education	E	1944 to 1963	1964 to 1983

Building category	CLIMATIC ZONE	PERIOD OF CONSTRUCTION	
(Schools)			

For those periods and for each category, the medium and the mode have been defined as to consider the most representative building for each cathegory, according to the available data. Table IT 3. summarizes results for offices.

Table IT 3 - Building general and dimensional data collection for offices

		Up to 1919		1920 to 1945		1946 to 1961		1962 to 1971		1972 to 1981		1982 to 1991		After 1991	
Characteristic	Symbol	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE
Total gross floor area [m^2]	A	958	225	715	225	512	225	579	225	560	225	1004	225	1004	225
Total net floor area [m^2]	A_n														
Footprint [m^2]	-	295	113	250	113	177	113	166	113	173	113	322	113	314	113
Envelope surface [m^2]	S_b	683	343	548	343	433	523	502	523	506	523	798	523	808	523
Window surface [m^2]	S_w	90	30	82	30	72	30	70	30	95	60	123	30	113	60
Gross volume [m^3]	V	3353	788	2501	788	1792	788	2025	788	1960	788	3513	788	3515	788
Net volume [m^3]	V_n														
Number of floors	-	3,2	2,0	2,9	2,0	2,9	2,0	3,5	2,0	3,2	2,0	3,1	2,0	3,2	2,0
Medium height of floor [m]	h	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5
Compactness ratio [m^{-1}]	S_b/V	0,20	0,44	0,22	0,44	0,24	0,66	0,25	0,66	0,26	0,66	0,23	0,66	0,23	0,66
Window/Envelope surface ratio	S_w/S_b	0,13	0,09	0,15	0,09	0,17	0,06	0,14	0,06	0,19	0,11	0,15	0,06	0,14	0,11
Window/Floor surface ratio	S_w/A_n	0,09	0,13	0,11	0,13	0,14	0,13	0,12	0,13	0,17	0,27	0,12	0,13	0,11	0,27

Finally, the Public Administration of the Turin metropolitan area has been asked to check up to two real public buildings for each building category. The choise should respect either the project data collection achieved, and the Public Administration real interest in performing the building refurbishment. The following public buildings have thus been chosen:

- SOCIAL HOUSING
  a) Via Ivrea/Carema, Turin (Ref. SocialHousing)
- OFFICES
  a) M.I.U.R. Administrative Service Center, Turin
- SCHOOLS
  a) High school Cattaneo, Turin (Ref. School)
  b) High School Einstein, Turin (Ref. School)

I. Building category: Educational buildings

Subcategory: Schools

Table IT 4: Educational buildings, Schools

Building category		**Educational building**
Subcategory		**School**
Conditioned area	m^2	Net: 8764
Conditioned volume	m^3	41781 (33772)
Climatic zone E		Ref.number: School01 City: Turin
Part 1: Building (gym) geometry		
Walls, north west, M9, pillar	m^2	38,88
Walls, north west, M7, wall 3	m^2	619,35
Walls, south east, M9, pillar	m^2	38,88

Walls, south east, M7, wall 3	m^2	545,61
Walls, south west, M9, pillar	m^2	19,44
Walls, south west, M7, wall 3	m^2	343,73
Walls, north east, M9, pillar	m^2	19,44
Walls, north east, M7, wall 3	m^2	345,60
Windows, north west, F2	m^2	25,41
Windows, south west, F2	m^2	13,31
Windows, south east, F2	m^2	49,61
Windows, south east, F4	m^2	38,50
Windows, south east, F10	m^2	11,04
Windows, north east, F2	m^2	14,52
Roof S2	m^2	855,48
Windows (roof), F14	m^2	157,32
Floor on the ground P3	m^2	1012,80
Part 1: Building (school) geometry		
Walls, north west, M10, pillar	m^2	66,24
Walls, north west, M5, wall 1	m^2	835,29
Walls, north west, M8, wall 4	m^2	81,00
Walls, south east, M10, pillar	m^2	66,24
Walls, south east, M5, wall 1	m^2	944,66
Walls, south west, M10, pillar	m^2	22,08
Walls, south west, M5, wall 1	m^2	249,38
Walls, north east, M10, pillar	m^2	22,08
Walls, north east, M5, wall 1	m^2	322,42
Walls, on C.T. M11	m^2	99
Windows, north west, F2	m^2	159,72
Windows, north west, F8	m^2	68,40
Windows, north west, F7	m^2	36,45
Windows, north west, F12	m^2	28,86
Windows, north west, F16	m^2	62,00
Windows, south west, F9	m^2	13,68
Windows, south west, F7	m^2	4,05
Windows, south east, F2	m^2	246,84
Windows, south east, F11	m^2	26,86
Windows, south east, F15	m^2	24,48
Windows, south east, F16	m^2	93,00
Windows, north east, F7	m^2	2,43

Roof on unconditioned space S1	m^2	1841,59	
Windows (roof), F6	m^2	(25,41)	
Floor on the ground P1	m^2	1763,00	
Floor on C.T. P2	m^2	103,75	
Floor on outside P4	m^2	34,50	
Part 2: Building (Gym&School) properties			
Uwalls	W/m^2K	Prior to investment	Requirement at 2014
Uwalls M5	W/m^2K	0,88	0,34
Uwalls M8	W/m^2K	1,17	0,34
Uwalls M10	W/m^2K	2,52	0,34
Uwalls M11	W/m^2K	1,90	0,34
Upillar P1	W/m^2K	0,24	0,34
Upillar P2	W/m^2K	0,84	0,34
Upillar P4	W/m^2K	0,92	0,34
ΔUtb	W/m^2K		
b(ground)	-	0,53	
b(un-conditioned space)	-	0,70	
b(adjacent sunspace)	-		
b(adjacent building)	-		
Uwindows	W/m^2K	Prior to investment	Requirement at 2014
Uwindows F2	W/m^2K	3,87	2,2
Uwindows F6	W/m^2K	5,79	2,2
Uwindows F7	W/m^2K	4,04	2,2
Uwindows F8	W/m^2K	3,48	2,2
Uwindows F9	W/m^2K	3,87	2,2
Uwindows F11	W/m^2K	6,23	2,2
Uwindows F12	W/m^2K	3,42	2,2
Uwindows F15	W/m^2K	3,38	2,2
Uwindows F16	W/m^2K	3,57	2,2
fraction of the window frame area	%	17%	
g(F)	0,75	Total solar energy transmittance for window incl. external shading for normal incidence	
Uroof	W/m^2K	Prior to investment	Requirement at 2014
Uroof S1	W/m^2K	0,93	0,30

Uroof S3	W/m^{2}K	0,97	0,30
Ufloor	W/m^{2}K	Prior to investment	Requirement at 2014
Ufloor P1	W/m^{2}K	0,24	0,33
Ufloor P2	W/m^{2}K	0,84	0,33
Ufloor P4	W/m^{2}K	0,92	0,33
ε	-	0,84 Glass 0,90 Opaque components	
α	-	0,3-0,6	
Infiltration, occupancy period	h^{-1}	1,12	
Infiltration, non occupancy	h^{-1}	1,12	
Thermal capacity	Wh/m^{2}K	43 referred to the total building envelope area	

Part 3: Internal gains and operational schedule		
Sensible heat gains	W/m²	4
Latent heat gains	W/m²	0,011 school 0,008 gym
Weekdays	h/day	8
Saturdays	h/day	8
Sundays	h/day	8
Metabolic heat (occupants)	W/m²	0
Latent metabolic heat	W/m²	0 for cooling calculation
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting for illumination	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Latent heat	W/m²	0 For cooling calculations
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	24
Saturdays	°C	20	h/day	24
Sundays	°C	20	h/day	24
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system

Emission efficiency	%	96,2
Distribution efficiency	%	97
Automatic control	%	82,5
Generation efficiency	%	78,6
Energy source (fuel, energy carrier)	-	natural gas
Fans/pumps room units	W/m²	-
Pumps heating system	W/m²	1,72
Pumps pre-heating ventilation	W/m²	-

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	32,85
Temperature difference	°C	27,2
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

II. Building category: Educational buildings

Subcategory: Schools

Table IT4: Educational buildings, Schools

Building category		**Educational building**
Subcategory		**School**
Conditioned area	m^2	8798 (school) 2149 (gym&theatre)
Conditioned volume	m^3	27339 (school)

		7957 (gym&theatre)
Climatic zone E		Ref.number: School02 City: Turin
Part 1: Building geometry (level -1)		
Walls, north east, M14	m^2	27,36
Walls, north east, M13	m^2	134,30
Walls, north west, M14	m^2	23,04
Walls, north west, M13	m^2	139,09
Walls, south west, M14	m^2	37,44
Walls, south west, M13	m^2	143,78
Door on unconditioned space, M4	m^2	4,04
Door on unconditioned space, M5	m^2	2,13
Walls on unconditioned space, M19	m^2	146,89
Walls, south east, M14	m^2	44,64
Walls, south east, M13	m^2	197,38
Windows, north east, F20	m^2	15,54
Windows, north east, F8	m^2	38,02
Windows, north east, F30	m^2	3,08
Windows, north west, F10	m^2	7,92
Windows, north west, F20	m^2	49,73
Windows, south west, F8	m^2	59,75
Windows, south west, F27	m^2	8,06
Windows, south west, F29	m^2	1,68
Windows, south west, F20	m^2	3,11
Windows, south east, F10	m^2	14,51
Windows, south east, F8	m^2	54,32
Windows, south east, F20	m^2	34,19
Floor on ground, P1	m^2	1700
Part 1: Building geometry (ground floor)		
Walls, north east, M14	m^2	28,63
Walls, north east, M13	m^2	126,61
Walls, north west, M14	m^2	41,63
Walls, north west, M13	m^2	184,45
Walls, south west, M14	m^2	43,07
Walls, south west, M13	m^2	112,66
Walls, south east, M14	m^2	51,84
Walls, south east, M13	m^2	162,45

Windows, north east, F1	m^2	33,4
Windows, north east, F2	m^2	18,34
Windows, north east, F8	m^2	51,60
Windows, north east, F9	m^2	4,89
Windows, north west, F8	m^2	76,05
Windows, north west, F18	m^2	2,91
Windows, north west, F3	m^2	3,45
Windows, north west, F19	m^2	2,54
Windows, north west, F10	m^2	10,55
Windows, north west, F9	m^2	2,44
Windows, south west, F8	m^2	78,76
Windows, south west, F9	m^2	2,44
Windows, south west, F1	m^2	16,70
Windows, south west, F2	m^2	9,17
Windows, south east, F3	m^2	6,90
Windows, south east, F10	m^2	15,83
Windows, south east, F8	m^2	97,78
Floor on unconditioned space, P2	m^2	204
Part 1: Building geometry (level 1)		
Walls, north east, M14	m^2	28,68
Walls, north east, M13	m^2	126,87
Walls, north west, M14	m^2	41,63
Walls, north west, M13	m^2	182,77
Walls, south west, M14	m^2	43,20
Walls, south west, M13	m^2	106,97
Walls, south east, M14	m^2	51,84
Walls, south east, M13	m^2	164,07
Windows, north east, F15	m^2	16,70
Windows, north east, F16	m^2	8,91
Windows, north east, F13	m^2	5,93
Windows, north east, F14	m^2	3,24
Windows, north east, F11	m^2	10,80
Windows, north east, F12	m^2	5,90
Windows, north east, F8	m^2	51,60
Windows, north east, F9	m^2	4,89
Windows, north west, F8	m^2	76,05
Windows, north west, F10	m^2	21,11

Windows, north west, F9	m^2	2,44
Windows, south west, F8	m^2	81,48
Windows, south west, F10	m^2	5,28
Windows, south west, F11	m^2	10,80
Windows, south west, F12	m^2	5,90
Windows, south west, F13	m^2	5,93
Windows, south west, F14	m^2	3,24
Windows, south east, F10	m^2	21,11
Windows, south east, F8	m^2	97,78
Part 1: Building geometry (level 2)		
Walls, north east, M14	m^2	28,68
Walls, north east, M13	m^2	126,87
Walls, north west, M14	m^2	41,63
Walls, north west, M13	m^2	182,77
Walls, south west, M14	m^2	43,20
Walls, south west, M13	m^2	106,97
Walls, south east, M14	m^2	51,84
Walls, south east, M13	m^2	164,07
Windows, north east, F15	m^2	16,70
Windows, north east, F16	m^2	8,91
Windows, north east, F13	m^2	5,93
Windows, north east, F14	m^2	3,24
Windows, north east, F11	m^2	10,80
Windows, north east, F12	m^2	5,90
Windows, north east, F8	m^2	51,60
Windows, north east, F9	m^2	4,89
Windows, north west, F8	m^2	76,05
Windows, north west, F10	m^2	21,11
Windows, north west, F9	m^2	2,44
Windows, south west, F8	m^2	81,48
Windows, south west, F10	m^2	5,28
Windows, south west, F11	m^2	10,80
Windows, south west, F12	m^2	5,90
Windows, south west, F13	m^2	5,93
Windows, south west, F14	m^2	3,24
Windows, south east, F10	m^2	21,11
Windows, south east, F8	m^2	97,78

Roof on unconditioned space, S2	m^2	38,81
Roof on outside, S1	m^2	1828,79
Part 1: Building geometry (level 3)		
Walls, north east, M13	m^2	18,32
Walls, north west, M13	m^2	6,32
Walls, south east, M13	m^2	4,09
Wall on unconditioned space, M19		26,59
Door, south east, M2	m^2	1,71
Door on unconditioned space, M1	m^2	2,10
Door on unconditioned space, M3	m^2	2,63
Windows, north west, F10	m^2	5,28
Windows, north east, F17	m^2	9,52
Roof on outside, S1	m^2	36,40
Part 1: Building geometry (gym&theatre)		
Walls, north east, M15	m^2	63,14
Walls, north east, M17	m^2	112,75
Walls, north west, M18	m^2	32,40
Walls, north west, M15	m^2	110,17
Walls, north west, M17	m^2	230,91
Walls, south west, M15	m^2	32,91
Walls, south west, M17	m^2	92,86
Walls, south east, M16	m^2	30,38
Walls, south east, M15	m^2	77,73
Walls, south east, M17	m^2	210,10
Door, south east, M9	m^2	3,30
Door, south east, M7	m^2	3,82
Door, north east, M6	m^2	3,08
Door, north east, M12	m^2	2,75
Door, north west, M7	m^2	3,82
Door, north west, M12	m^2	2,75
Windows, north west, F23	m^2	24,31
Windows, north west, F25	m^2	41,60
Windows, north west, F24	m^2	1,20
Windows, north west, F6	m^2	10,08
Windows, north west, F7	m^2	5,04
Windows, north west, F26	m^2	4,28

Windows, north west, F22	m^2	90,64
Windows, south west, F23	m^2	24,32
Windows, south west, F24	m^2	2,41
Windows, south east, F31	m^2	1,62
Windows, south east, F25	m^2	39
Windows, south east, F24	m^2	2,41
Windows, south east, F23	m^2	43,78
Windows, south east, F22	m^2	90,64
Floor on ground	m^2	662,37
Floor on unconditioned space, P2	m^2	53,94
Roof on outside, S1	m^2	716,31

Part 2: Building (Gym&School) properties

Uwalls	W/m^2K	Prior to investment	Requirement at 2014
Udoor M1	W/m^2K	4,07	2,2
Udoor M2	W/m^2K	6,03	2,2
Udoor M3	W/m^2K	4,07	2,2
Udoor M4	W/m^2K	1,84	2,2
Udoor M5	W/m^2K	4,07	2,2
Udoor M6	W/m^2K	6,03	2,2
Udoor M7	W/m^2K	6,03	2,2
Udoor M9	W/m^2K	6,03	2,2
Udoor M12	W/m^2K	6,03	2,2
Uwalls M13	W/m^2K	0,91	0,34
Uwalls M14	W/m^2K	1,40	0,34
Uwalls M15	W/m^2K	0,83	0,34
Uwalls M16	W/m^2K	1,18	0,34
Uwalls M17	W/m^2K	1,20	0,34
Uwalls M18	W/m^2K	1,40	0,34
Uwalls M19	W/m^2K	1,88	0,80
ΔUtb	W/m^2K	-	
b(ground)	-	0,45	
b(un-conditioned space)	-	0,27	
b(adjacent sunspace)	-		
b(adjacent building)	-		
Uwindows	W/m^2K	Prior to investment	Requirement at 2014

Uwindows F1	W/m^{2}K	5,60	2,2
Uwindows F2	W/m^{2}K	5,59	2,2
Uwindows F3	W/m^{2}K	5,71	2,2
Uwindows F6	W/m^{2}K	5,67	2,2
Uwindows F7	W/m^{2}K	5,67	2,2
Uwindows F8	W/m^{2}K	3,55	2,2
Uwindows F9	W/m^{2}K	3,58	2,2
Uwindows F10	W/m^{2}K	5,98	2,2
Uwindows F11	W/m^{2}K	3,41	2,2
Uwindows F12	W/m^{2}K	5,79	2,2
Uwindows F13	W/m^{2}K	3,40	2,2
Uwindows F14	W/m^{2}K	5,81	2,2
Uwindows F15	W/m^{2}K	3,32	2,2
Uwindows F16	W/m^{2}K	3,31	2,2
Uwindows F17	W/m^{2}K	5,95	2,2
Uwindows F18	W/m^{2}K	6,01	2,2
Uwindows F19	W/m^{2}K	6,17	2,2
Uwindows F20	W/m^{2}K	3,52	2,2
Uwindows F22	W/m^{2}K	5,73	2,2
Uwindows F23	W/m^{2}K	6,01	2,2
Uwindows F24	W/m^{2}K	6,20	2,2
Uwindows F25	W/m^{2}K	5,78	2,2
Uwindows F26	W/m^{2}K	5,96	2,2
Uwindows F27	W/m^{2}K	3,62	2,2
Uwindows F29	W/m^{2}K	4,43	2,2
Uwindows F30	W/m^{2}K	3,63	2,2
Uwindows F31	W/m^{2}K	3,65	2,2
Uwindows F6	W/m^{2}K		2,2
Uwindows F7	W/m^{2}K		2,2
Uwindows F8	W/m^{2}K		2,2
fraction of the window frame area	%	17%	
g(F)	0,85	Total solar energy transmittance for window incl. external shading for normal incidence	
Uroof	W/m^{2}K	Prior to investment	Requirement at 2014
Uroof S1	W/m^{2}K	1,00	0,30
Uroof S2	W/m^{2}K	0,93	0,80
Ufloor	W/m^{2}K	Prior to investment	Requirement at 2014

Ufloor P1	W/m^{2}K	0,29	0,33
Ufloor P2	W/m^{2}K	0,83	0,80
ε	-	0,84 Glass 0,90 Opaque components	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,5 (gym) 2,5 (theatre) 1,7 (school)	
Infiltration, non occupancy	h^{-1}	0,5 (gym) 2,5 (theatre) 1,7 (school)	
Thermal capacity	Wh/m^{2}K	46 referred to the total building envelope area	
Part 3: Internal gains and operational schedule			
Sensible heat gains	W/m²	4	
Latent heat gains	W/m²	0,011 school 0,019 theatre 0,008 gym	
Weekdays	h/day	8	
Saturdays	h/day	8	
Sundays	h/day	8	
Metabolic heat (occupants)	W/m²	0	
Latent metabolic heat	W/m²	0 For cooling calculations	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Lighting for illumination	W/m²	0	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Lighting, emergency/controls	W/m²	0	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m²	0	
Weekdays	h/day		
Saturdays	h/day		

Sundays	h/day	
Latent heat	W/m²	0 For cooling calculations
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	24
Saturdays	°C	20	h/day	24
Sundays	°C	20	h/day	24
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system

Emission efficiency	%	96,7
Distribution efficiency	%	97,2
Automatic control	%	82,9
Generation efficiency	%	77,4
Energy source (fuel, energy carrier)	-	natural gas
Fans/pumps room units	W/m²	-
Pumps heating system	W/m²	1,00
Pumps pre-heating ventilation	W/m²	-

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	

Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems

Quantity	l/m²year	32,85
Temperature difference	°C	27,2
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	95,1%
Energy source (fuel, energy carrier)	-	natural gas
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	

Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

III. Building category: Residential buildings

Subcategory: Social housing

Table IT5: Residential buildings, Social housing

Building category		**Residential**
Subcategory		**Social housing**
Conditioned area	m^2	16280

Conditioned volume	m^3	50485
Climatic zone E		Ref.number: SocialHousing01 City: Turin

Part 1: Building geometry		
Walls, north, M1	m^2	378,2
Walls, south, M1	m^2	378,2
Walls, east, M1	m^2	3037,6
Walls, west, M1	m^2	2989,6
Windows, north, F1	m^2	19,2
Windows, north, F2	m^2	6,0
Windows, north, F4	m^2	33,6
Windows, south, F1	m^2	19,2
Windows, south, F2	m^2	6,0
Windows, south, F4	m^2	33,6
Windows, east, F1	m^2	268,8
Windows, east, F2	m^2	72
Windows, east, F3	m^2	201,6
Windows, west, F1	m^2	556,8
Windows, west, F3	m^2	33,6
Roof S1	m^2	1990
Floor on unconditioned space P1	m^2	1628

Part 2: Building properties			
Uwalls	W/m^2K	Prior to investment	Requirement at 2014
Uwalls M1	W/m^2K	1,43	0,34
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-	0,80	
b(adjacent sunspace)	-		
b(adjacent building)	-		
Uwindows	W/m^2K	Prior to investment	Requirement at 2014
Uwindows F1	W/m^2K	5,70	2,2
Uwindows F2	W/m^2K	5,70	2,2
Uwindows F3	W/m^2K	5,70	2,2
Uwindows F4	W/m^2K	5,70	2,2

fraction of the window frame area	%	20%	
g(F)	0,75	Total solar energy transmittance for window incl. external shading for normal incidence	
Uroof	W/m^{2}K	Prior to investment	Requirement at 2014
Uroof S1	W/m^{2}K	1,35	0,30
Ufloor	W/m^{2}K	Prior to investment	Requirement at 2014
Ufloor P1	W/m^{2}K	1,59	0,33
ε	-	0,84 Glass 0,90 Opaque components	
α	-	0,3-0,6	
Infiltration, occupancy period	h^{-1}	0,3	
Infiltration, non occupancy	h^{-1}	0,3	
Thermal capacity	Wh/m^{2}K	43 referred to the total building envelope area	

Part 3: Internal gains and operational schedule		
Sensible heat gains	W/m²	5,8
Latent heat gains	W/m²	2,95
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Metabolic heat (occupants)	W/m²	0
Latent metabolic heat	W/m²	0 for cooling calculation
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting for illumination	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	0
Weekdays	h/day	
Saturdays	h/day	

Sundays	h/day	
Latent heat	W/m²	0 For cooling calculations
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	24
Saturdays	°C	20	h/day	24
Sundays	°C	20	h/day	24
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system

Emission efficiency	%	95
Distribution efficiency	%	94
Automatic control	%	96
Generation efficiency	%	95
Energy source (fuel, energy carrier)	-	natural gas
Fans/pumps room units	W/m²	-
Pumps heating system	W/m²	1,2
Pumps pre-heating ventilation	W/m²	-

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	

Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems

Quantity	l/m²year	361
Temperature difference	°C	27,2
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	95
Energy source (fuel, energy carrier)	-	natural gas
Pumps, DHW system	W/m²	0,3

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

IV. Building category: Office/Administrative buildings

Subcategory: Offices

Table IT6: Office buildings, Offices

Building category		**Office**
Subcategory		**Office**
Conditioned area	m^2	2772
Conditioned volume	m^3	9240

Climatic zone E		Ref.number: Officel01 City: Turin
Part 1: Building geometry		
Walls, north, M1	m^2	481,8
Walls, south, M1	m^2	481,8
Walls, east, M1	m^2	260,2
Walls, west, M1	m^2	260,2
Windows, north, F1	m^2	178,2
Windows, south, F1	m^2	178,2
Windows, east, F1	m^2	19,8
Windows, west, F1	m^2	19,8
Roof S1	m^2	462
Floor on unconditioned space P1	m^2	462

Part 2: Building properties			
Uwalls	W/m^2K	Prior to investment	Requirement at 2014
Uwalls M1	W/m^2K	0,76	0,34
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-	0,80	
b(adjacent sunspace)	-		
b(adjacent building)	-		
Uwindows	W/m^2K	Prior to investment	Requirement at 2014
Uwindows F1	W/m^2K	3,20	2,2
fraction of the window frame area	%	20%	
g(F)	0,75	Total solar energy transmittance for window incl. external shading for normal incidence	
Uroof	W/m^2K	Prior to investment	Requirement at 2014
Uroof S1	W/m^2K	0,83	0,30
Ufloor	W/m^2K	Prior to investment	Requirement at 2014
Ufloor P1	W/m^2K	0,52	0,33
ε	-	0,84 Glass 0,90 Opaque components	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	1,06	

Infiltration, non occupancy	h^{-1}	1,06
Thermal capacity	Wh/m^2K	43 referred to the total building envelope area
Part 3: Internal gains and operational schedule		
Sensible heat gains	W/m²	6
Latent heat gains	W/m²	0,004
Weekdays	h/day	8
Saturdays	h/day	8
Sundays	h/day	8
Metabolic heat (occupants)	W/m²	0
Latent metabolic heat	W/m²	0 for cooling calculation
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting for illumination	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting, emergency/controls	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	0
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Latent heat	W/m²	0 For cooling calculations
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating mode				
	Set-point temperature		**Duration**	
Weekdays	°C	20	h/day	24
Saturdays	°C	20	h/day	24
Sundays	°C	20	h/day	24
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system		
Emission efficiency	%	97
Distribution efficiency	%	96
Automatic control	%	97
Generation efficiency	%	93
Energy source (fuel, energy carrier)	-	natural gas
Fans/pumps room units	W/m²	-
Pumps heating system	W/m²	0,5
Pumps pre-heating ventilation	W/m²	-

Part 7: Mechanical ventilation system (heating mode)				
	Supply temperature		**Duration**	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems		
Quantity	l/m²year	73
Temperature difference	°C	27,2
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	93
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	0,1

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				

Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

PORTUGAL

I. Building category: Residential buildings

Subcategory: Social housing (1961 – 1990)

The reference building for a building category/Subcategory can be defined as a building with representative for the building category parameters as follows:

- Built-up/conditioned area; 65 - 105 m^2
- Building age; <1990 - 55,55% 1991 to 2006 - 39,30% 2007 to 2013 - 5,15
- Construction materials and corresponding thermal properties of the building envelope;
- Occupancy schedule;
- Technical systems/installations for maintaining the built environment;
- Operational pattern;
- Energy carriers used for heating.

	Building age	Built-up/conditioned area (m^2)
Residential Buildings	<1960	65
	1961 - 1990	70
	1991 - 2012	95
	>2012	105

	Building age	Construction materials - Thermal properties of the building envelope			
		WALLS	ROOF	FLOOR	WINDONS
Single Family	<1960	Ordinary masonry stone wall, plastered on both sides (50 cm) - 2,00	Sloping roof with ceramic tile, lightened slab (15 cm) plastered with 2cm of stucco – 2,80	Tile coating, screed 4 cm, 15 cm lightened slab and ceiling coating cm 2 plaster – 2,10	Single glass with wooden frame – 5,1 Shading device
	1961-1990	Single brick wall, brick masonry 22, plastered on both sides (26 cm) - 1,76	Sloping roof with ceramic tile, lightened slab (15 cm) plastered with 2cm of stucco – 2,80	Tile coating, screed 4 cm, 15 cm lightened slab and ceiling coating cm 2 plaster – 2,10	Single glass with metallic frame without thermal cut – 5,2 Shading
	1991-2012	Double brick wall, brick masonry 11 + 11 with 3cm of insulation in the air space, plastered on both sides (30 cm) - 0,92	Sloping roof with ceramic tile, lightened slab (15 cm) covered with 3cm of thermal insulation and plastered with 2cm plaster – 0,94	Tile coating, screed 4 cm, 3 cm insulation, lightened slab of 15 cm and ceiling coating cm 2 plaster – 0,78	Single glass with metallic frame without thermal cut – 5,2 Shading

In residential buildings is assumed that are occupied all days and overall all year (365 days) an the mean internal gains are equal to 4 W/m^2

The *data* obtained from the Energy Performance Certificates *database* of *ADENE*, the Portuguese Energy Agency and managing body for the *National* System for Energy the only technical systems or installations used for maintaining the built environment are, gas heaters or, in the most recent buildings.

Table PT1: Residential buildings

Building category		**Residential Buildings**
Subcategory		**1961-1990**
Conditioned area	m^2	**70** Based on internal dimensions, external dimensions or overall internal dimensions
Conditioned volume	m^3	**70 x 2,7 =**
Climatic zone		Lisbon (Winter: I1; Summer: V2) Z = 109 m
Part 1: Building (Zone) geometry		
Walls, north	m^2	**19,10** Total wall area excl. windows
Walls, east	m^2	**-** Total wall area excl. windows
Walls, south	m^2	**19,10**

		Total wall area excl. windows
Walls, west	m^2	**19,10** Total wall area excl. windows
Windows, north	m^2	**3,5** Window area incl. frames
Windows, east	m^2	**-** Window area incl. frames
Windows, south	m^2	**3,5** Window area incl. frames
Windows, west	m^2	**3,5** Window area incl. frames
Roof	m^2	**70,0**
Floor	m^2	**70,0**

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,76	Requirement at 2014 Winter Zone I1 / I2 / I3 0,70/ 0,60 / 0,50
ΔUtb	W/m^2K	U value x 1,35	
b(ground)	-	EN ISO 13370	
b(un-conditioned space)	-	EN ISO 13789,	
b(adjacent sunspace)	-	EN ISO 13789	
b(adjacent building)	m^2	Default value: 0,6	
Uwindows	W/m^2K	Prior to investment **5,2**	Requirement at 2014 2,9 winter zone: I1
fraction of the window frame area	%	**0,65 – 0,70**	
g(F)	-	Total solar energy transmittance for window incl. external shading. 0,30	
Uroof	W/m^2K	Prior to investment 2,80	Requirement at 2014 0,50 winter zone: I1
Ufloor	W/m^2K	Prior to investment 2,10	Requirement at 2014 0,50 winter zone: I1
ε	-	Emissivity for external walls (depending on type of materials and surface) Low emissivity or ventilated air gap: 0,10 Other situations: 0,25	

α	-	Solar absorption for external walls (depending on colour surface) 0,4 – 0,5 - 0,8
Infiltration, occupancy period	m3/ h.person	Minimum air flow rate expressed in h^{-1} Winter: 0,4 Summer: 0,6
Infiltration, non occupancy	$m^3/h.m^2$	n.a.
Thermal capacity	Wh/m^2K	medium expressed in kg/m^2
Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	**(a)**
Latent metabolic heat	W/m²	For cooling calculations -
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting for illumination	DPI (W/m2-100lux	**(a)**
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Lighting, emergency/controls	W/m²	**(a)**
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Latent heat	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

(a) residential buildings are assumed that are occupied all days and all over the year (365 days) an the mean internal gains are equal to 4 W/m^2 .

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**	**(b)**

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	h/day with set-point temperature calculation of heating energy demands
Saturdays	°C	20	h/day	See above
Sundays	°C	20	h/day	See above
Unoccupied period	°C	20		See above
Holidays	°C	20		See above

Part 6: Heating system

Emission efficiency	%	Not installed
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Energy source (fuel, energy carrier)	-	
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n.a
Saturdays	°C		h/day	n.a.
Sundays	°C		h/day	n.a
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				

Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Quantity	l/m²year	40 l per person per day 40 l x 365 days each person
Temperature difference	°C	+ 35 ºC
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C	25	h/day	h/day with set-point temperature calculation of cooling energy demands summer period 1st June – 30th September
Saturdays	°C		h/day	summer period 1st June – 30th September
Sundays	°C		h/day	summer period 1st June – 30th September
Unoccupied period	°C			summer period 1st June – 30th September
Holidays	°C			summer period 1st June – 30th September

Part 10: Cooling system

Emission efficiency	%	Not installed
Distribution efficiency	%	
Automatic control	%	

Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	Residential buildings are assumed to be always occupied
Saturdays	°C		h/day	Residential buildings are assumed to be always occupied
Sundays	°C		h/day	Residential buildings are assumed to be always occupied

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	n.a.
Saturdays	W/m²	h/day	n.a.
Sundays	W/m²	h/day	n.a

The residential building legislation concerning the equipment's imposes minimum efficiency requirements on:

Boilers used for space heating where the class minimum efficiency after depending on the year according to the next 2 tables:

Equipment	Minimum efficiency class after…	
	Entry into force	31 Dec 2015
Boiler	B	A

(1) - Class A, where operating temperatures do not permit installation of harnessing the energy released by the condensation of flue gas.

Boilers energy efficiency classes, for space heating, in terms of the nominal efficiency

Energy efficiency class	Nominal efficiency (η)
A+ +	$\eta \geq 96\%$
A +	$96\ \% \geq \eta > 92\%$
A	$92\ \% \geq \eta > 89\%$
B	$89\ \% \geq \eta > 86\%$
C	$86\ \% \geq \eta > 83\%$
D	$83\ \% \geq \eta > 80\%$
E	$89\ \% \geq \eta > 77\%$
F	$\eta \leq 77$

Cooling systems: minimum efficiency requirements depending on their classification for certification (www.eurovent-certification.com) or performance evaluated by the same reference standard, with the requirement equivalent in terms of COP and EER and the tests should be performed by accredited entity

Air conditioning systems: minimum efficiency requirements depending on their classification for certification (www.eurovent-certification.com) or performance evaluated by the same reference standard, with the requirement equivalent in terms of COP and EER and the tests should be performed by accredited entity

Concerning the renewable energy systems the building code includes guidelines for solar thermal systems, solar photovoltaic systems, micro wind systems, biomass boilers and geothermal systems.

II Building category: Office/Public administration

Subcategory: Offices

Definition of data

The reference building for a building category/sub-category can be defined as a building with representative for the building category parameters as follows:

- Built-up/conditioned area; 5705,8 m^2

- Building age; after 1990
- Construction materials and corresponding thermal properties of the building envelope;
- 1990< Office < 2006, - thermal properties of the building envelope – corresponding to the national norms of 1990
- Office < 1990 single brick wall or lightweight concrete blocks

Occupancy schedule; 7:00 – 20:00 (weekdays only)

Technical systems/installations for maintaining the built environment;

Operational pattern; 08:00-19:00 (weekdays only)

Energy carriers used for heating: 44 % VRF; 24 % chiller and DHW 75% heater; 21% boiler

Data collection

All necessary data: geometrical, building energy usage, base heat supply regime (type of the heating system, energy resource, etc.) etc., which would allow to perform simulation of the energy consumption, should be collected.

Table PT2: Template for reporting the reference building input data

Building category		**Offices**
Sub-category		1990< Office < 2006
Conditioned area	m^2	**5705,8** Based on internal dimensions, external dimensions or overall internal dimensions
Conditioned volume	m^3	**19399,6**
Climatic zone		Lisbon (Winter: I1; Summer: V2) Z = 109 m
Part 1: Building (Zone) geometry		
Walls, north	m^2	**348,8** Total wall area excl. windows
Walls, east	m^2	**348,8** Total wall area excl. windows
Walls, south	m^2	**348,8** Total wall area excl. windows
Walls, west	m^2	**348,8** Total wall area excl. windows
Windows, north	m^2	**263,2** Window area incl. frames
Windows, east	m^2	**263,2** Window area incl. frames
Windows, south	m^2	**263,2** Window area incl. frames
Windows, west	m^2	**263,2**

		Window area incl. frames	
Roof	m^2	**1296,0**	
Floor	m^2	**1296,0**	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,32	Requirement at 2014 Winter Zone I1 / I2 / I3 0,70/ 0,60 / 0,50
ΔUtb	W/m^2K	U value x 1,35	
b(ground)	-	Default value:0,8	
b(un-conditioned space)	-	Default value:0,8	
b(adjacent sunspace)	-	Default value:0,8	
b(adjacent building)	m^2	Default value:0,6	
Uwindows	W/m^2K	Prior to investment **4,39**	Requirement at 2014 0,70 – winter zone: I1
fraction of the window frame area	%	**0,57 – 0,90**	
g(F)	-	Total solar energy transmittance for window incl. external shading. 0**,45**	
Uroof	W/m^2K	Prior to investment 2,1	Requirement at 2014 0,50 winter zone: I1
Ufloor	W/m^2K	Prior to investment 1,65	Requirement at 2014 0,50 winter zone: I1
ε	-	Emissivity for external walls (depending on type of materials and surface) Low emissivity or ventilated air gap: 0,10 Other situations: 0,25	
α	-	Solar absorption for external walls (depending on type of materials and surface) 0,4 – 0,5-0,8	
Infiltration, occupancy period	m3/ h.person	Minimum air flow rate per person Office: 20 m^3/ h.person	
Infiltration, non occupancy	$m^3/h.m^2$	3 $m^3/h.m^2$	
Thermal capacity	Wh/m^2K	medium and heavy class according to standard	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	Average metabolic heat during the operation period **75**
Latent metabolic heat	W/m²	For cooling calculations
Weekdays	h/day	No. of hours with the metabolic heat for a normal weekday 6:00- 20 h (with different %: 10%- 100%)
Saturdays	h/day	0%
Sundays	h/day	0%
Lighting for illumination	DPI (W/m2-100lux	Average lighting power during the operation period 2,5
Weekdays	h/day	6:00- 20 h (with different %: 10%- 100%)
Saturdays	h/day	0%
Sundays	h/day	0%
Lighting, emergency/controls	W/m²	Average lighting power during the operation period
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	Average simultaneous power from appliances during the operation period 15
Weekdays	h/day	6:00- 20 h (with different %: 10%- 100%)
Saturdays	h/day	
Sundays	h/day	
Latent heat	W/m²	For cooling calculations
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
No. of holidays (excluding	1			2	1	1	-	1	-	-	-	2

weekends)												

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	h/day with set-point temperature
Saturdays	°C		h/day	no control
Sundays	°C		h/day	no control
Unoccupied period	°C			no control
Holidays	°C			no control

Part 6: Heating system

Emission efficiency	%	3,08 % of equipment: SPLIT (63%) -CHILLER (18%)
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Energy source (fuel, energy carrier)	-	electricity
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				

Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems		
Quantity	l/m²year	From the legislation default value for small office (<1000 m^2) 100 l, all values are accepted including 0 l. There is no specific annual consumption of hot water in the legislation
Temperature difference	°C	+ 35 ºC
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	0,93 (storage heater)
Energy source (fuel, energy carrier)	-	electricity
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C	25	h/day	h/day with set-point temperature
Saturdays	°C		h/day	no control
Sundays	°C		h/day	no control
Unoccupied period	°C			no control
Holidays	°C			no control

Part 9: Cooling system

Emission efficiency	%	2,85 % of equipment: SPLIT (61%) -CHILLER (35%)
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	n/a
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 10: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 11: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

ROMANIA

According to the analysis of the public building stock in Romania (from inventory of existing buildings owned and occupied by central administration and adding estimated building data from local public administration – mainly offices and schools), the biggest share, in terms of total floor area and primary energy consumption, is represented by office buildings (30% of total floor area and 36% of total primary energy consumption) and by educational buildings (56% of total floor area and 51% of total primary energy consumption).

One reference building has been selected for each of these building categories, taking into consideration the average characteristics (total floor area, shape, thermal characteristics, use and primary energy). One should note that the building stock data did not permit the detailed definition

of a virtual building (average statistical characteristics), but facilitated the choice of existing buildings which are similar to the average performance of the considered building categories in the public building stock.

The two defined reference buildings are presented in Table RO 1 and Table RO 2, detailing the necessary data which would allow performing simulation of the energy consumption (geometrical, building energy usage, base heat supply etc.).

I. Building category: Offices/Public administration

Subcategory: Central authorities

- Average characteristics from the analysis of public building stock:
- Total built-up area: 2,352 m²,
- Useful area of conditioned space: 2,074 m²,
- Land area occupied by the building: 707 m²,
- Average number of floors: GF + 3,6 Levels
- Construction materials – concrete + light cellular concrete blocks; thermal properties of the building envelope – corresponding to existing public building stock,
- Occupancy schedule – 10 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) based on natural gas burning water heating boiler
  b) based on district heating.

Table RO 1: Offices/Public administration, Central authorities – Administrative Buildings

Building category		**OFFICES/PUBLIC ADMINISTRATION**
Subcategory		**Central authorities – Administrative Building**
Conditioned area	m^2	1,872 (overall internal dimensions)
Conditioned volume	m^3	5,275 (net conditioned volume)
Climatic zone		Climatic zone II City: Bucharest
Part 1: Building (Zone) geometry		
Walls, north	m^2	188,58
Walls, east	m^2	127,85
Walls, south	m^2	188,58
Walls, south-west	m^2	-
Walls, west	m^2	127,60
Walls, north-west	m^2	-
Windows, north	m^2	239,7
Windows, east	m^2	71,6

Windows, south	m^2	239,7	
Windows, west	m^2	71,6	
Windows, north-west	m^2	-	
Roof	m^2	375,00	
Floor	m^2	375,00	
Walls adjacent to staircase	m^2	856,56	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,586	Requirement at 2014 0,625
ΔUtb	W/m^2K	0,11 (included in U-value)	
b(ground)	-	calculated	
b(un-conditioned space)	-	calculated	
b(adjacent sunspace)	-	-	
b(adjacent building)	-	calculated	
Uwindows	W/m^2K	Prior to investment 2,564	Requirement at 2014 2,0
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,676	
Uroof (to the external air)	W/m^2K	Prior to investment 1,127	Requirement at 2014 0,25
Ufloor (to unheated basement)	W/m^2K	Prior to investment 3,074	Requirement at 2014 0,43
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	1,08	
Infiltration, non occupancy	h^{-1}	1,08	
Thermal capacity	Wh/m^2K	73,91	
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	13,28	
Latent metabolic heat	W/m²	0	
Weekdays	h/day	10	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²	4,7	
Weekdays	h/day	9	
Saturdays	h/day	0	

Sundays	h/day	0
Lighting, emergency/controls	W/m²	2,5
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Appliances	W/m²	9,2
Weekdays	h/day	10
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	0
Weekdays	h/day	0
Saturdays	h/day	0
Sundays	h/day	0

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	1	1	1	0	1	0	0	1	3

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	10
Saturdays	°C	12	h/day	24
Sundays	°C	12	h/day	24
Unoccupied period	°C	12		
Holidays	°C	12		

Part 6: Heating system

Emission efficiency	%	97
Distribution efficiency	%	98,2
Automatic control	%	92
Generation efficiency	%	100
Energy source (fuel, energy carrier)	-	District heating
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,55

Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C	20	h/day	10
Saturdays	°C		h/day	-
Sundays	°C		h/day	-
Ventilation rate, occupancy period, m³/hm²			-	
Ventilation rate, non-occupancy, m³/hm²			-	
Heat recovery efficiency, %			n/a	
Emission efficiency, %			-	
Distribution efficiency, %			-	
Automatic control, %			-	
Generation efficiency, %			-	
Energy source (fuel, energy carrier)			-	
Fans, occupancy period, W/m²			-	
Fans, non-occupancy period, W/m²			-	

Part 8: Domestic hot water systems

Quantity	l/m²year	115
Temperature difference	°C	40
Distribution efficiency	%	80
Automatic control %	%	100
Generation efficiency %	%	80
Energy source (fuel, energy carrier)	-	District heating
Pumps, DHW system	W/m²	0

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	26	h/day	10
Saturdays	°C	29	h/day	24
Sundays	°C	29	h/day	24
Unoccupied period	°C	29		-
Holidays	°C	29		-

Part 10: Cooling system

Emission efficiency	%	100
Distribution efficiency	%	100
Automatic control	%	100
Generation efficiency	%	250
Fans/pumps room units	W/m²	-
Pumps cooling system	W/m²	-

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C	26	h/day	-
Saturdays	°C		h/day	-
Sundays	°C		h/day	-
Ventilation rate, occupancy period, m³/hm²			-	
Ventilation rate, non-occupancy, m³/hm²			-	
Heat recovery efficiency, %			n/a	
Night – cooling, m³/hm²			n/a	
Free – cooling, m³/hm²			n/a	
Emission efficiency,%			-	
Distribution efficiency, %			-	
Automatic control, %			-	
Generation efficiency, %			-	
Fans, occupancy period, W/m²			-	
Fans, non-occupancy period, W/m²			-	
Fans, night cooling, W/m²			n/a	
Fans, free-cooling, W/m²			n/a	

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	4,5 W/m²	h/day	24
Saturdays	4,5 W/m²	h/day	24
Sundays	4,5 W/m²	h/day	24

II. Building category: Educational buildings

Subcategory: Schools

- Average characteristics from the analysis of public building stock:

- Total built-up area: 2,660 m²,
- Useful area of conditioned space: 2,294 m²,
- Land area occupied by the building: 1,021 m²,
- Average number of floors: GF + 2,2 Levels
- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to existing educational building stock,
- Occupancy schedule – 13 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) based on natural gas burning water heating boiler
  b) based on district heating.

Table RO 2: Educational buildings, Schools

Building category		**EDUCATIONAL BUILDINGS**	
Subcategory		**School**	
Conditioned area	m^2	1857,6 (overall internal dimensions)	
Conditioned volume	m^3	6470 (net conditioned volume)	
Climatic zone		Climatic zone II City: Bucharest	
Part 1: Building (Zone) geometry			
Walls, north-west	m^2	356,61	
Walls, north-east	m^2	200,46	
Walls, south-east	m^2	441,41	
Walls, south-west	m^2	201,31	
Windows, north-west	m^2	54,72	
Windows, north-east	m^2	54,24	
Windows, south-east	m^2	211,20	
Windows, south-west	m^2	53,52	
Roof	m^2	713,63	
Floor	m^2	713,63	
Walls adjacent to staircase	m^2	351,96	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,927	Requirement at 2014 0,625
ΔUtb	W/m^2K	0,40 (included in U-value)	
b(ground)	-	calculated	
b(un-conditioned space)	-	calculated	
b(adjacent sunspace)	-	-	
b(adjacent building)	m^2	calculated	

Uwindows	W/m^{2}K	Prior to investment 2,564	Requirement at 2014 1,45
fraction of the window frame area	%	taken into account in Uwindows and g	
g(F)	-	0,676	
Uroof (to external air)	W/m^{2}K	Prior to investment 1,342	Requirement at 2014 0,22
Ufloor (to unheated basement)	W/m^{2}K	Prior to investment 2,929	Requirement at 2014 0,43
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,35	
Infiltration, non occupancy	h^{-1}	0,35	
Thermal capacity	Wh/m^{2}K	73,91	
Part 3: Internal gains and operational schedule			
Metabolic heat (occupants)	W/m²	16,06	
Latent metabolic heat	W/m²	n/a	
Weekdays	h/day	-	
Saturdays	h/day	-	
Sundays	h/day	-	
Lighting for illumination	W/m²	7,5	
Weekdays	h/day	9	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting, emergency/controls	W/m²	0,66	
Weekdays	h/day	24	
Saturdays	h/day	24	
Sundays	h/day	24	
Appliances	W/m²	7,5	
Weekdays	h/day	13	
Saturdays	h/day	0	
Sundays	h/day	0	
Latent heat	W/m²	n/a	
Weekdays	h/day	-	
Saturdays	h/day	-	
Sundays	h/day	-	
Part 4: Holidays			

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	5	5	0	7	1	12	23	20	10	0	1	9

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	13
Saturdays	°C	12	h/day	24
Sundays	°C	12	h/day	24
Unoccupied period	°C	12		
Holidays	°C	12		

Part 6: Heating system

Emission efficiency	%	97
Distribution efficiency	%	98,2
Automatic control	%	92
Generation efficiency	%	100
Energy source (fuel, energy carrier)	-	District heating
Fans/pumps room units	W/m²	0
Pumps heating system	W/m²	0,55
Pumps pre-heating ventilation	W/m²	0

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C	20	h/day	13
Saturdays	°C		h/day	-
Sundays	°C		h/day	-
Ventilation rate, occupancy period, m³/hm²			2,9	
Ventilation rate, non-occupancy, m³/hm²			-	
Heat recovery efficiency, %			n/a	
Emission efficiency, %			-	
Distribution efficiency, %			-	
Automatic control, %			-	
Generation efficiency, %			-	

Energy source (fuel, energy carrier)	-
Fans, occupancy period, W/m²	-
Fans, non-occupancy period, W/m²	-

Part 8: Domestic hot water systems

Quantity	l/m²year	91,3
Temperature difference	°C	40
Distribution efficiency	%	80
Automatic control %	%	100
Generation efficiency %	%	80
Energy source (fuel, energy carrier)	-	District heating
Pumps, DHW system	W/m²	0

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C	26	h/day	13
Saturdays	°C	29	h/day	24
Sundays	°C	29	h/day	24
Unoccupied period	°C	29		-
Holidays	°C	29		-

Part 10: Cooling system

Emission efficiency	%	100
Distribution efficiency	%	100
Automatic control	%	100
Generation efficiency	%	250
Fans/pumps room units	W/m²	-
Pumps cooling system	W/m²	-

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C	26	h/day	13
Saturdays	°C		h/day	-
Sundays	°C		h/day	-
Ventilation rate, occupancy period, m³/hm²			2,9	
Ventilation rate, non-occupancy, m³/hm²			-	

Heat recovery efficiency, %	n/a
Night – cooling, m³/hm²	n/a
Free – cooling, m³/hm²	n/a
Emission efficiency,%	-
Distribution efficiency, %	-
Automatic control, %	-
Generation efficiency, %	-
Fans, occupancy period, W/m²	-
Fans, non-occupancy period, W/m²	-
Fans, night cooling, W/m²	n/a
Fans, free-cooling, W/m²	n/a

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	4,5 W/m²	h/day	24
Saturdays	4,5 W/m²	h/day	24
Sundays	4,5 W/m²	h/day	24

SLOVENIA

Definition of data

The reference buildings for a building category/subcategory are defined as a building with representative for the building category parameters as follows:

- Total net floor conditioned area;
- Building age;
- Construction materials and corresponding thermal properties of the building envelope;
- Occupancy schedule: according to the category, several are proposed;

For the purpose of this work, all reference buildings have the same climate conditions with a default location – Ljubljana, characterized by 3,300 heating degree days. The lowest average temperature in Ljubljana is -1°C in January, the highest is in July – 20°C (Table SI 1). The average yearly temperature is 9,7°C. The design outdoor temperature for sizing the heating systems is -13°C in the heating season (depends on the location within the country). The number of hours of sunshine for Ljubljana is between 1800 and 1900 hours per year, the global horizontal radiation is 1121 kWh/m2a.

Table SI 1: Monthly climatic data for Ljubljana (ARSO[5])

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°C	-1	1	6	10	15	18	20	19	15	10	4	1
Relative humidity	%	82	77	72	71	73	72	75	76	80	82	84	85
Radiation	kWh/m^{2}a	917	1731	2759	4049	4894	5274	5469	4739	3354	1911	983	698

Reference building was formed in two steps. At first the average values of indicators were identified and in the end, a real building was found that correlates the best to the average values and is a potential for a renovation.

Table SI1: Observed public building categories through indicators

BUILDING TYPE	CLIMATIC ZONE	PERIOD OF CONSTUCTION	CONDITIONED FLOOR AREA [m2]	SHAPE FACTOR [m(-1)]	SHARE OF THE GLAZING
Office/Public	Ljubljana	1980	1300	0,43	8 %
Kindergarten	Ljubljana	1983	1170	0,66	8 %
School	Ljubljana	1982	2290	0,44	11 %
Health-care	Ljubljana	1967	2220	0,50	10 %
Social housing	Ljubljana	1978	4489	0,33	13 %

According to the upper table:

- Thermal envelope from buildings built between 1980 and 1983 is going to correspond thermal properties based on the Regulation from 1980;
- Thermal envelope from buildings built in 1978 is going to correspond thermal properties based on the Regulation from 1970;
- Thermal envelope from buildings built in 1967 is going to correspond thermal properties based on the Regulation from 1963;
- The most commonly used energy carriers in public buildings are natural gas and district heating, hence both will be used in further analyses.

To gather all the necessary data in order to form reference buildings, next sources of information were used:

- Register of EPC,
- Register of Real Estates,
- Survey of energy efficiency on non-residential building (REUS).

Based on the characteristics of the reference buildings indicators, real public buildings have been chosen as a representative for its category.

Data collection

The main conclusions of the analysis of the five selected representative building categories are as follows:

I. Building category: Offices/Public administration

Subcategory: Central authorities – Administrative buildings

- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1980,
- Occupancy schedule:
  a) 8 h/day 5 days/week,
  b) 12 h/day 5 days/week,

- Technical systems: central heating with three options:
  a) Low-temperature gas boiler
  b) District heating

Table SI2: Offices/Public administration

Building category		**OFFICES/PUBLIC ADMINISTRATION**	
Sub-category		**Central authorities – Administrative Building**	
Conditioned area	m^2	1299 (internal dimensions)	
Conditioned volume	m^3	3769 (net volume)	
Climatic zone		Ref. number: 1 City: Ljubljana	
Part 1: Building (Zone) geometry			
Walls, north	m^2	231,0	
Walls, east	m^2	109,0	
Walls, south	m^2	237,0	
Walls, west	m^2	123,0	
Windows, north	m^2	33	
Windows, east	m^2	43	
Windows, south	m^2	27	
Windows, west	m^2	27	
Roof	m^2	430,0	
Floor	m^2	430,0	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,28
Uwalls (to the terrain)	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,8	Requirement at 2014 1,3
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,60	
Uroof (to the external air)	W/m^2K	Prior to investment	Requirement at 2014

		0,6	0,20
Ufloor (to the external air)	W/m^{2}K	Prior to investment 1,0	Requirement at 2014 0,30
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period (fixed)	h^{-1}	0,5	
Infiltration, non-occupancy (fixed)	h^{-1}	0,5	
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Thermal capacity	Wh/m^{2}K	130	
Part 3: Internal gains and operational schedule			
Sensible heat gains	W/m²	6,0	
Latent metabolic heat	W/m²	0	
Weekdays	h/day	8 ; 12	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²		
Weekdays	h/day	8 ; 12	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting, emergency/controls	W/m²		
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m²	3,0	
Weekdays	h/day	8 ; 12	
Saturdays	h/day	0	
Sundays	h/day	0	
Latent heat	W/m²	0	
Weekdays	h/day	8 ; 12	
Saturdays	h/day	0	
Sundays	h/day	0	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8 ; 12
Saturdays	°C	20	h/day	0
Sundays	°C	20	h/day	0
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system

Emission efficiency	%	96
Distribution efficiency	%	95
Automatic control	%	85
Generation efficiency	%	80
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				

Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	

Part 8: Domestic hot water systems

Specific daily energy consumption	l/(m²year)	30
Temperature difference	°C	30
Distribution efficiency	%	95
Automatic control %	%	
Generation efficiency %	%	95
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Pumps, DHW system	W/m²	0,3

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C	26	h/day	9
Saturdays	°C	26	h/day	24
Sundays	°C	26	h/day	24
Unoccupied period	°C	26		
Holidays	°C	26		

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				

Heat recovery efficiency, %	
Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

II.Building category: Kindergarten

- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1980,
- Occupancy schedule:
  a) 8 h/day 5 days/week,
  b) 12 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) Low-temperature gas boiler
  b) District heating

Table SI3: Kindergarten

Building category		**EDUCATIONAL BUILDINGS**
Sub-category		**Kindergarten**
Conditioned area	m^2	1520 (internal dimensions)
Conditioned volume	m^3	4644 (net volume)
Climatic zone		Ref. number: 1 City: Ljubljana
Part 1: Building (Zone) geometry		
Walls, north	m^2	373,45
Walls, east	m^2	184,27

Walls, south	m^2	158,38	
Walls, west	m^2	253,24	
Windows, north	m^2	25,62	
Windows, east	m^2	149,95	
Windows, south	m^2	51,77	
Windows, west	m^2	97,54	
Roof	m^2	896	
Floor	m^2	656	
Floor above basement	m^2	240	
Doors	m^2	47	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,28
Uwalls (to the terrain)	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,8	Requirement at 2014 1,3
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,60	
Uroof (to the external air)	W/m^2K	Prior to investment 0,6	Requirement at 2014 0,20
Ufloor (to the external air)	W/m^2K	Prior to investment 1,0	Requirement at 2014 0,30
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period (fixed)	h^{-1}	0,5	
Infiltration, non-occupancy (fixed)	h^{-1}	0,5	
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	

Thermal capacity	Wh/m^{2}K	130
Part 3: Internal gains and operational schedule		
Sensible heat gains	W/m²	6,0
Latent metabolic heat	W/m²	0
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	1,0
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	0,0
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8 ; 12
Saturdays	°C	20	h/day	0
Sundays	°C	20	h/day	0

Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system		
Emission efficiency	%	96
Distribution efficiency	%	95
Automatic control	%	85
Generation efficiency	%	80
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)				
	Supply temperature		**Duration**	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems		
Specific daily energy consumption	l/(m²year)	170
Temperature difference	°C	30
Distribution efficiency	%	95
Automatic control %	%	
Generation efficiency %	%	95
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Pumps, DHW system	W/m²	0,3

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C	26	h/day	9
Saturdays	°C	26	h/day	24
Sundays	°C	26	h/day	24
Unoccupied period	°C	26		
Holidays	°C	26		

Part 10: Cooling system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	

Ventilation rate, occupancy period, m³/hm²	
Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

III.Building category: School

- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1980,
- Occupancy schedule:
  a) 8 h/day 5 days/week,
  b) 12 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) Low-temperature gas boiler
  b) District heating

Table SI4: School

Building category		**EDUCATIONAL BUILDINGS**
Sub-category		**School**
Conditioned area	m^2	3125 (internal dimensions)
Conditioned volume	m^3	13367 (net volume)
Climatic zone		Ref. number: 1 City: Ljubljana
Part 1: Building (Zone) geometry		
Walls, north	m^2	356,4
Walls, east	m^2	507,1
Walls, south	m^2	297,0
Walls, west	m^2	488,7
Windows, north	m^2	114,56
Windows, east	m^2	264,44
Windows, south	m^2	124,82
Windows, west	m^2	273,73
Roof	m^2	1472
Roof, inclined 15°, west	m^2	40,67
Roof, inclined 15°, east	m^2	40,67
Floor	m^2	1637
Doors	m^2	5,65

Part 2: Building (Zone) properties			
Uwalls	W/m^{2}K	Prior to investment 0,8	Requirement at 2014 0,28
Uwalls (to the terrain)	W/m^{2}K	Prior to investment 0,8	Requirement at 2014 0,35
ΔUtb	W/m^{2}K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^{2}K	Prior to investment 2,8	Requirement at 2014 1,3
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,60	
Uroof (to the external air)	W/m^{2}K	Prior to investment 0,6	Requirement at 2014 0,20
Ufloor (to the external air)	W/m^{2}K	Prior to investment 1,0	Requirement at 2014 0,30
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period (fixed)	h^{-1}	0,5	
Infiltration, non-occupancy (fixed)	h^{-1}	0,5	
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Thermal capacity	Wh/m^{2}K	145	

Part 3: Internal gains and operational schedule		
Sensible heat gains	W/m²	6,0
Latent metabolic heat	W/m²	0
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	
Weekdays	h/day	8 ; 12

Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	1,0
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	0,0
Weekdays	h/day	8 ; 12
Saturdays	h/day	0
Sundays	h/day	0

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8 ; 12
Saturdays	°C	20	h/day	0
Sundays	°C	20	h/day	0
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system

Emission efficiency	%	96
Distribution efficiency	%	95
Automatic control	%	85
Generation efficiency	%	80
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Fans/pumps room units	W/m²	

Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems

Specific daily energy consumption	l/(m²year)	500
Temperature difference	°C	30
Distribution efficiency	%	95
Automatic control %	%	
Generation efficiency %	%	95
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Pumps, DHW system	W/m²	0,3

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	26	h/day	9
Saturdays	°C	26	h/day	24
Sundays	°C	26	h/day	24
Unoccupied period	°C	26		
Holidays	°C	26		

Part 10: Cooling system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

IV.Building category: Health-care facilities

- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1980,
- Occupancy schedule:

a) 8 h/day 5 days/week,
b) 12 h/day 5 days/week,
c) 8 h/day 7 days/week,
d) 12 h/day 7 days/week

- Technical systems: central heating with two options:
  a) Low-temperature gas boiler
  b) District heating

Table SI5: Health-care facilities

Building category		**HEALTH-CARE FACILITY**	
Sub-category		**Hospital**	
Conditioned area	m^2	3144 (internal dimensions)	
Conditioned volume	m^3	12035 (net volume)	
Climatic zone		Ref. number: 1 City: Ljubljana	
Part 1: Building (Zone) geometry			
Walls, north	m^2	143,14	
Walls, east	m^2	391,25	
Walls, south	m^2	187,24	
Walls, west	m^2	190,8	
Wall against the terrain	m^2	152,8	
Windows, north	m^2	72,36	
Windows, east	m^2	76,56	
Windows, south	m^2	83,76	
Windows, west	m^2	187,2	
Roof	m^2	1822	
Floor	m^2	1606,8	
Doors	m^2	54,8	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,2	Requirement at 2014 0,28
Uwalls (to the terrain)	W/m^2K	Prior to investment 1,2	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		

Uwindows	W/m^{2}K	Prior to investment 2,3	Requirement at 2014 1,3
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,60	
Uroof (to the external air)	W/m^{2}K	Prior to investment 1,2	Requirement at 2014 0,20
Ufloor (to the external air)		Prior to investment 1,4	Requirement at 2014 0,30
ε	- W/m^{2}K	0,9	
α	-	0,6	
Infiltration, occupancy period (fixed)	h^{-1}	0,5	
Infiltration, non-occupancy (fixed)	h^{-1}	0,5	
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5	
Thermal capacity	Wh/m^{2}K	90	

Part 3: Internal gains and operational schedule

Sensible heat gains	W/m²	6,0
Latent metabolic heat	W/m²	0
Weekdays	h/day	8 ; 12 ; 8; 12
Saturdays	h/day	0 ; 0 ; 8; 12
Sundays	h/day	0 ; 0 ; 8; 12
Lighting for illumination	W/m²	
Weekdays	h/day	8 ; 12 ; 8; 12
Saturdays	h/day	0 ; 0 ; 8; 12
Sundays	h/day	0 ; 0 ; 8; 12
Lighting, emergency/controls	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	3,0
Weekdays	h/day	8 ; 12 ; 8; 12
Saturdays	h/day	0 ; 0 ; 8; 12
Sundays	h/day	0 ; 0 ; 8; 12

Latent heat	W/m²	0,0
Weekdays	h/day	8 ; 12 ; 8; 12
Saturdays	h/day	0 ; 0 ; 8; 12
Sundays	h/day	0 ; 0 ; 8; 12

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	22	h/day	8 ; 12 ; 8; 12
Saturdays	°C	22	h/day	0 ; 0 ; 8; 12
Sundays	°C	22	h/day	0 ; 0 ; 8; 12
Unoccupied period	°C	22		
Holidays	°C	22		

Part 6: Heating system

Emission efficiency	%	96
Distribution efficiency	%	95
Automatic control	%	85
Generation efficiency	%	80
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				

Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Emission efficiency, %	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Energy source (fuel, energy carrier)	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	0

Part 8: Domestic hot water systems

Specific daily energy consumption	l/(m²year)	530
Temperature difference	°C	30
Distribution efficiency	%	95
Automatic control %	%	
Generation efficiency %	%	95
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Pumps, DHW system	W/m²	0,3

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C	26	h/day	9
Saturdays	°C	26	h/day	24
Sundays	°C	26	h/day	24
Unoccupied period	°C	26		
Holidays	°C	26		

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature	Duration

Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

V.Building category: Social housing

- Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1980,
- Occupancy schedule:
  a) 24 h/day 5 days/week,
  b) 24 h/day 7 days/week,
- Technical systems: central heating with two options:
  a) Low-temperature gas boiler
  b) District heating

Table SI6: Home for elderly people

Building category		**RESIDENTIAL**
Sub-category		**Social housing**
Conditioned area	m^2	4633 (internal dimensions)

Conditioned volume	m^3	12923 (net volume)	
Climatic zone		Ref. number: 1 City: Ljubljana	
Part 1: Building (Zone) geometry			
Walls, north	m^2	192,15	
Walls, east	m^2	622	
Walls, south	m^2	134,6	
Walls, west	m^2	591,3	
Windows, north	m^2	72,85	
Windows, east	m^2	264	
Windows, south	m^2	112,4	
Windows, west	m^2	298,7	
Roof	m^2	512	
Roof against the unheated space	m^2	920	
Floor	m^2	1432	
Doors	m^2	12	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,28
Uwalls (to the terrain)	W/m^2K	Prior to investment 0,8	Requirement at 2014 0,35
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 2,8	Requirement at 2014 1,3
fraction of the window frame area	%	taken into account in Uwindow and g	
g(F)	-	0,60	
Uroof (to the external air)	W/m^2K	Prior to investment 0,6	Requirement at 2014 0,20
Ufloor (to the external air)	W/m^2K	Prior to investment 1,0	Requirement at 2014 0,30
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period (fixed)	h^{-1}	0,5	

Infiltration, non-occupancy (fixed)	h^{-1}	0,5
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	h^{-1}	3,5
Thermal capacity	Wh/m^2K	211
Part 3: Internal gains and operational schedule		
Sensible heat gains	W/m²	6,0
Latent metabolic heat	W/m²	0
Weekdays	h/day	24 ; 24
Saturdays	h/day	0 ; 24
Sundays	h/day	0 ; 24
Lighting for illumination	W/m²	
Weekdays	h/day	24 ; 24
Saturdays	h/day	0 ; 24
Sundays	h/day	0 ; 24
Lighting, emergency/controls	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	2,0
Weekdays	h/day	24 ; 24
Saturdays	h/day	0 ; 24
Sundays	h/day	0 ; 24
Latent heat	W/m²	0
Weekdays	h/day	24 ; 24
Saturdays	h/day	0 ; 24
Sundays	h/day	0 ; 24

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2

Part 5: Heating mode				
	Set-point temperature		**Duration**	
Weekdays	°C	20	h/day	24 ; 24
Saturdays	°C	20	h/day	0 ; 24
Sundays	°C	20	h/day	0 ; 24
Unoccupied period	°C	20		
Holidays	°C	20		

Part 6: Heating system		
Emission efficiency	%	96
Distribution efficiency	%	95
Automatic control	%	85
Generation efficiency	%	80
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)				
	Supply temperature		**Duration**	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems

Specific daily energy consumption	l/(m^{2}year)	450
Temperature difference	°C	30
Distribution efficiency	%	95
Automatic control %	%	
Generation efficiency %	%	95
Energy source (fuel, energy carrier)	-	Natural gas/district heating
Pumps, DHW system	W/m²	0,3

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	26	h/day	9
Saturdays	°C	26	h/day	24
Sundays	°C	26	h/day	24
Unoccupied period	°C	26		
Holidays	°C	26		

Part 10: Cooling system

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				

Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

SPAIN, CATALONIA

The main conclusions of the analysis of the two selected representative building categories are as follows:

I. Building category: Offices/Public administration

Subcategory: Regional authorities

- The reference building should have built-up area more than 5000 m2,
- Construction materials: the building should be constructed between 1980 and 2006. Thermal properties of the building envelope – corresponding to 1st energy regulation for buildings (NBE-CT-79),
- Occupancy schedule – 12 h/day 5 days/week,
- Technical systems: electrical heat pump.

Table SP1: Office/Public Administration, Regional authorities

Building category		**Office/Public Administration**
Subcategory		**Regional authorities**
Conditioned area	m^2	7899,85
Conditioned volume	m^3	19749,63
Climatic zone		Ref. number: C2 City: Barcelona
Part 1: Building (Zone) geometry		
Walls, N	m^2	570
Walls, NE	m^2	240,6
Walls, NO		560,99
Walls, SE_1	m^2	84,93

Walls, SE	m^2	621,3
Windows, N	m^2	372,70
Windows, NE	m^2	89,28
Windows, NO	m^2	274,83
Windows, SE	m^2	402,9
Roof	m^2	921
Floor	m^2	2337

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment Façade: 1,98/ Back wall 2,77	Requirement at 2014 0,75
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 3,3/5,7	Requirement at 2014 3,1
fraction of the window frame area	%	0,3	
g(F)	-	0,75/0,82	
Uroof	W/m^2K	Prior to investment 2,27	Requirement at 2014 0,5
Ufloor	W/m^2K	Prior to investment 2,61	Requirement at 2014 0,7
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,28	
Infiltration, non occupancy	h^{-1}	0,28	
Thermal capacity	Wh/m^2K		

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	4,37
Latent metabolic heat	W/m²	4,37
Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	11,90

Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	18,35
Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	
Weekdays	h/day	
Saturdays	h/day	0
Sundays	h/day	0

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	0	1	2	0	2	0	1	2	0	1	5

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	21	h/day	12
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 6: Heating system

Emission efficiency	%	94
Distribution efficiency	%	99
Automatic control	%	
Generation efficiency	%	2,84 (COP)
Energy source (fuel, energy carrier)	-	electricity

Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	13
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²			2,62	
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)			electricity	
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems

Quantity	l/m²year	n.a.
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode

	Set-point temperature		Duration	
Weekdays	°C	25	h/day	12
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	97
Distribution efficiency	%	99
Automatic control	%	
Generation efficiency	%	2,59 (EER)
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	13
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²			2,62	
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	1,84 W/m²	h/day	12
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

II. Building category: Health-care facilities

Subcategory: Hospitals

- The reference building should have built-up area should be higher than 10 000 m2,

- Construction materials: the building should be constructed between 1980 and 2006. Thermal properties of the building envelope – corresponding to 1st energy regulation for buildings (NBE-CT-79).
- Occupancy schedule – 24 h/day 7 days/week
- Technical systems:
  a) Natural gas boilers
  b) Electric chillers

Table ES2: Health-care facilities, Hospitals

Building category		**Health-care facilities**	
Subcategory		**Hospitals**	
Conditioned area	m^2	14254,00	
Conditioned volume	m^3	35635,00	
Climatic zone		Ref. number: B3 City: Tarragona	
Part 1: Building (Zone) geometry			
Walls, north	m^2	13436,46	
Walls, east	m^2	5661,25	
Walls, south	m^2	13316,65	
Walls, west	m^2	5059,03	
Windows, north	m^2	347,70	
Windows, east	m^2	55,31	
Windows, south	m^2	228,71	
Windows, west	m^2	51,29	
Roof	m^2	1543,00	
Floor	m^2	2548,00	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,277	Requirement at 2014 1
ΔUtb	W/m^2K		
b(ground)	-		
b(un-conditioned space)	-		
b(adjacent sunspace)	-		
b(adjacent building)	m^2		
Uwindows	W/m^2K	Prior to investment 3,69/2,85	Requirement at 2014 4,2
fraction of the window frame area	%	0,3	
g(F)	-	0,75/0,8	

Uroof	W/m^{2}K	Prior to investment 2,215	Requirement at 2014 0,65
Ufloor	W/m^{2}K	Prior to investment 2,61	Requirement at 2014 1
ε	-	0,9	
α	-	0,6	
Infiltration, occupancy period	h^{-1}	0,28	
Infiltration, non occupancy	h^{-1}	0,28	
Thermal capacity	Wh/m^{2}K		

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	6,33
Latent metabolic heat	W/m²	6,47
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Lighting for illumination	W/m²	5,70
Weekdays	h/day	11
Saturdays	h/day	11
Sundays	h/day	11
Lighting, emergency/controls	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	5,82
Weekdays	h/day	24
Saturdays	h/day	24
Sundays	h/day	24
Latent heat	W/m²	
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	-	-	-	-	-	-	-	-	-	-	-	-

Part 5: Heating mode				
	Set-point temperature		**Duration**	
Weekdays	°C	24	h/day	24
Saturdays	°C	24	h/day	24
Sundays	°C	24	h/day	24
Unoccupied period	°C			
Holidays	°C			

Part 6: Heating system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	82
Energy source (fuel, energy carrier)	-	Natural gas
Fans/pumps room units	W/m²	
Pumps heating system	W/m²	
Pumps pre-heating ventilation	W/m²	

Part 7: Mechanical ventilation system (heating mode)				
	Supply temperature		**Duration**	
Weekdays	°C	24	h/day	24
Saturdays	°C	24	h/day	24
Sundays	°C	24	h/day	24
Ventilation rate, occupancy period, m³/hm²			20	
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %			75	
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)			electricity	
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems		
Quantity	l/m²year	92,57
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	82
Energy source (fuel, energy carrier)	-	Natural gas/water
Pumps, DHW system	W/m²	

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C	21	h/day	24
Saturdays	°C	21	h/day	24
Sundays	°C	21	h/day	24
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	2,27 (EER)
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C	21	h/day	24
Saturdays	°C	21	h/day	24
Sundays	°C	21	h/day	24
Ventilation rate, occupancy period, m³/hm²			20	
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %			75	
Night – cooling, m³/hm²				
Free – cooling, m³/hm²			2,67	

Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	8,04W/m²	h/day	24
Saturdays	W/m²	h/day	24
Sundays	W/m²	h/day	24

THE FORMER YOUGOSLAV REPUBLIC OF MACEDONIA

I. Building category: Offices / Public administration

Subcategory: Student housing

- The reference building should have built-up area between 100 and 1000 m2,
- Construction materials – concrete +masonry; thermal properties of the building envelope
- Occupancy schedule – 8 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) based on light oil burning water heating boiler
  b) based on district heating

Table MK1: Template for reporting the reference building input data

Building category		**Offices / Public administration**
Sub-category		**Regional Local Authorities**
Conditioned area	m2	167
Conditioned volume	m^3	384
Climatic zone		Ref. number: 2 City: Skopje
Part 1: Building (Zone) geometry		
Walls, north	m^2	50
Walls, east	m^2	4,80
Walls, south	m^2	50

Walls, west	m^2	20,65
Windows, north	m^2	32,90
Windows, east	m^2	1,90
Windows, south	m^2	28,20
Windows, west	m^2	12,40
Roof	m^2	167
Floor	m^2	167

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,61	Requirement at 2014 0,35
ΔUtb	W/m^2K	/	
b(ground)	-	/	
b(un-conditioned space)	-	/	
b(adjacent sunspace)	-	/	
b(adjacent building)	m^2	/	
Uwindows	W/m^2K	Prior to investment 3,3	Requirement at 2014 1,3-2
fraction of the window frame area	%	20%	
g(F)	-	/	
Uroof	W/m^2K	Prior to investment 2,84	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 0,76	Requirement at 2014 0,4
ε	-	0,95	
α	-	/	
Infiltration, occupancy period	h^{-1}	0,5	
Infiltration, non occupancy	h^{-1}	0,5	
Thermal capacity	Wh/m^2K	69	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	8,38
Latent metabolic heat	W/m²	/
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	1,5
Weekdays	h/day	5
Saturdays	h/day	0

Sundays	h/day	0
Lighting, emergency/controls	W/m²	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/
Appliances	W/m²	45
Weekdays	h/day	6
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	4	0	0	2	3	0	1	2	1	2	0	1

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	8
Saturdays	°C	0	h/day	0
Sundays	°C	0	h/day	0
Unoccupied period	°C	0		0
Holidays	°C	0		0

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	100
Generation efficiency	%	100
Energy source (fuel, energy carrier)	-	Electricity
Fans/pumps room units	W/m²	/
Pumps heating system	W/m²	0,41

Pumps pre-heating ventilation	W/m²	/

Part 7: Mechanical ventilation system (heating mode) N/A

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems N/A

Quantity	l/m²year	
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode N/A

	Set-point temperature		Duration	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system N/A		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode) N/A				
	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance N/A			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

II. Building category: Educational buildings

Subcategory: Schools

- The reference building should have built-up area between 1000 and 5000 m2,
- Construction materials – concrete +masonry; thermal properties of the building envelope
- Occupancy schedule – 16 h/day 5 days/week,
- Technical systems: central heating with two options:
  a) based on light oil burning water heating boiler
  b) based on district heating

Table MK2: Template for reporting the reference building input data

Building category		**Educational buildings**	
Sub-category		**Schools**	
Conditioned area	m2	3822	
Conditioned volume	m^3	14466	
Climatic zone		Ref. number: 2 City: Skopje	
Part 1: Building (Zone) geometry			
Walls, north	m^2	436	
Walls, east	m^2	304	
Walls, south	m^2	459	
Walls, west	m^2	267	
Windows, north	m^2	271	
Windows, east	m^2	80,2	
Windows, south	m^2	356	
Windows, west	m^2	123,4	
Roof	m^2	1400	
Floor	m^2	1400	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,52	Requirement at 2014 0,35
ΔUtb	W/m^2K	/	
b(ground)	-	/	
b(un-conditioned space)	-	/	
b(adjacent sunspace)	-	/	
b(adjacent building)	m^2	/	
Uwindows	W/m^2K	Prior to investment 2,85	Requirement at 2014 1,3-2

fraction of the window frame area	%	20%	
g(F)	-	/	
Uroof	W/m^2K	Prior to investment 0,64	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 2,62	Requirement at 2014 0,4
ε	-	0,95	
α	-	/	
Infiltration, occupancy period	h^{-1}	0,5	
Infiltration, non occupancy	h^{-1}	0,5	
Thermal capacity	Wh/m^2K	72	

Part 3: Internal gains and operational schedule

Metabolic heat (occupants)	W/m²	6,13
Latent metabolic heat	W/m²	/
Weekdays	h/day	9
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	1,4
Weekdays	h/day	5
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/
Appliances	W/m²	2
Weekdays	h/day	3
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of	15	0	0	2	2	10	23	22	2	2	1	1

holidays (excluding weekends)												

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	20	h/day	16
Saturdays	°C	14	h/day	16
Sundays	°C	14	h/day	16
Unoccupied period	°C	14		16
Holidays	°C	14		16

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	N/A
Generation efficiency	%	100
Energy source (fuel, energy carrier)	-	District Heating
Fans/pumps room units	W/m²	/
Pumps heating system	W/m²	0,56
Pumps pre-heating ventilation	W/m²	/

Part 7: Mechanical ventilation system (heating mode) N/A

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				

Fans, occupancy period, W/m²		
Fans, non-occupancy period, W/m²		
Part 8: Domestic hot water systems N/A		
Quantity	l/m²year	
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode N/A

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			

Part 10: Cooling system N/A

Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode) N/A

	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				

Ventilation rate, non-occupancy, m³/hm²	
Heat recovery efficiency, %	
Night – cooling, m³/hm²	
Free – cooling, m³/hm²	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m²	
Fans, non-occupancy period, W/m²	
Fans, night cooling, W/m²	
Fans, free-cooling, W/m²	

Part 12: Appliances not influencing the thermal balance N/A

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

III. Building category: Educational buildings

Subcategory: Kindergartens

- The reference building should have built-up area between 500 and 3000 m2,
- Construction materials – concrete +masonry; thermal properties of the building envelope
- Occupancy schedule – 16 h/day 5-7 days/week,
- Technical systems: central heating with two options:
  a) based on light oil burning water heating boiler
  b) based on district heating

Table MK3: Template for reporting the reference building input data

Building category		**Educational buildings**
Sub-category		**Kindergartens**
Conditioned area	m2	625
Conditioned volume	m^3	3072
Climatic zone		Ref. number: 1 City: Pehcevo
Part 1: Building (Zone) geometry		
Walls, north	m^2	79

Walls, east	m^2	107
Walls, south	m^2	40
Walls, west	m^2	92
Windows, north	m^2	57.8
Windows, east	m^2	4
Windows, south	m^2	113,3
Windows, west	m^2	10
Roof	m^2	818
Floor	m^2	625

Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,67	Requirement at 2014 0,35
ΔUtb	W/m^2K	/	
b(ground)	-	/	
b(un-conditioned space)	-	/	
b(adjacent sunspace)	-	/	
b(adjacent building)	m^2	/	
Uwindows	W/m^2K	Prior to investment 3,8	Requirement at 2014 1,3-2
fraction of the window frame area	%	20%	
g(F)	-	/	
Uroof	W/m^2K	Prior to investment 1,59	Requirement at 2014 0,25
Ufloor	W/m^2K	Prior to investment 0,76	Requirement at 2014 0,4
ε	-	0,95	
α	-	/	
Infiltration, occupancy period	h^{-1}	0,5	
Infiltration, non occupancy	h^{-1}	0,5	
Thermal capacity	Wh/m^2K	60	

Part 3: Internal gains and operational schedule		
Metabolic heat (occupants)	W/m²	12,09
Latent metabolic heat	W/m²	/
Weekdays	h/day	10
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	9,1

Weekdays	h/day	4
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/
Appliances	W/m²	83,87
Weekdays	h/day	4
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	4	0	0	2	3	0	1	2	1	2	0	1

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	21	h/day	10
Saturdays	°C	0	h/day	0
Sundays	°C	0	h/day	0
Unoccupied period	°C	0		0
Holidays	°C	0		0

Part 6: Heating system

Emission efficiency	%	100
Distribution efficiency	%	95
Automatic control	%	N/A
Generation efficiency	%	70
Energy source (fuel, energy carrier)	-	District Heating

Fans/pumps room units	W/m²	/
Pumps heating system	W/m²	0,74
Pumps pre-heating ventilation	W/m²	/

Part 7: Mechanical ventilation system (heating mode) ***N/A***

	Supply temperature		**Duration**	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Energy source (fuel, energy carrier)				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				

Part 8: Domestic hot water systems ***N/A***

Quantity	l/m²year	
Temperature difference	°C	
Distribution efficiency	%	
Automatic control %	%	
Generation efficiency %	%	
Energy source (fuel, energy carrier)	-	
Pumps, DHW system	W/m²	

Part 9: Cooling mode ***N/A***

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	h/day with set-point temperature
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			

Holidays	°C			

Part 10: Cooling system N/A		
Emission efficiency	%	
Distribution efficiency	%	
Automatic control	%	
Generation efficiency	%	
Fans/pumps room units	W/m²	
Pumps cooling system	W/m²	

Part 11: Mechanical ventilation system (cooling mode) N/A				
	Supply temperature		Duration	
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %				
Night – cooling, m³/hm²				
Free – cooling, m³/hm²				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance N/A			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

UNITED KINGDOM

I. Building category: Office/Administrative buildings

Subcategory: Office

Table UK1:Office/administrative buildings

Building category		**Office**	
Subcategory		**Victorian Office Block**	
Conditioned area	m^2	1314	
Conditioned volume	m^3	3986	
Climatic zone		Ref. number: WC08LON - Current CIBSE TRY/DSY Hourly Weather Data Set - London City: London	
Part 1: Building (Zone) geometry			
Walls, north	m^2	258	
Walls, east	m^2	245	
Walls, south	m^2	204	
Walls, west	m^2	224	
Windows, north	m^2	40	
Windows, east	m^2	54	
Windows, south	m^2	66	
Windows, west	m^2	41	
Roof	m^2	485	
Floor	m^2	536	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 2,10	Requirement at 2014 0,30[1]
ΔUtb	W/m^2K	Calculation based on psi-values	
b(ground)	-	Included in U-values	
b(un-conditioned space)	-	Included in U-values	
b(adjacent sunspace)	-	Included in U-values	
b(adjacent building)	m^2	Included in U-values	
Uwindows	W/m^2K	Prior to investment 4,9	Requirement at 2014 1,8
fraction of the window frame area	%	10[2]	

[1] Approved Document L2B

g(F)	-	0,85	
Uroof	W/m^{2}K	Prior to investment 2,5	Requirement at 2014 0,18
Ufloor	W/m^{2}K	Prior to investment 1,0	Requirement at 2014 0,25
ε	-	0,93[3]	
α	-	0,65	
Infiltration, occupancy period	h^{-1}	1,5	
Infiltration, non occupancy	h^{-1}	1,5	
Thermal capacity	Wh/m^{2}K	38[4]	
Part 3: Internal gains and operational schedule			
Sensible Metabolic heat (occupants)	W/m²	120*nb occupants / area = 120/18 = 6.7	
Latent metabolic heat	W/m²	n/a	
Weekdays	h/day	10	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²	15[5]	
Weekdays	h/day	12	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting, emergency/controls	W/m²	Can be neglected compared to lighting for illumination	
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m²	15	
Weekdays	h/day	12	
Saturdays	h/day	0	
Sundays	h/day	0	
Latent heat	W/m²	For cooling calculations	

[2] Default value from NCM modelling guide for buildings other than dwellings in England
[3] Values for typical brick wall, http://www.solarmirror.com/fom/fom-serve/cache/43.html
[4] 600mm brick wall
[5] https://books.google.co.uk/books?id=YichPartackC&pg=PA89&lpg=PA89&dq=internal+gains+w/m2+lightings+in+office&source=bl&ots=mssC4Bx3oD&sig=FMI8KJI7JdUA50wJhwEX0dacMWE&hl=fr&sa=X&ei=Ria-VKK9Joqp7AbS1YHgCQ&ved=0CDoQ6AEwAw#v=onepage&q=internal%20gains%20w%2Fm2%20lightings%20in%20office&f=false

Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	3	0	0	2	2	0	0	2	0	0	0	5

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	22**Error! ookmark not defined.**	h/day	13
Saturdays	°C	12	h/day	13
Sundays	°C	12	h/day	13
Unoccupied period	°C	12		
Holidays	°C	12		

Part 6: Heating system

Emission efficiency	%	?
Distribution efficiency[6]	%	90
Automatic control	%	n/a
Generation efficiency	%	84
Energy source (fuel, energy carrier)	-	Natural gas
Fans/pumps room units	W/m²	?
Pumps heating system	W/m²	?
Pumps pre-heating ventilation	W/m²	?

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	n/a

[6] Taken to be Seasonal Coefficient of Performance (SCoP)

Sundays	°C		h/day	n/a
Ventilation rate, occupancy period, m³/hm²			n/a	
Ventilation rate, non-occupancy, m³/hm²			n/a	
Heat recovery efficiency, %			n/a	
Emission efficiency, %			n/a	
Distribution efficiency, %			n/a	
Automatic control, %			n/a	
Generation efficiency, %			n/a	
Energy source (fuel, energy carrier)			n/a	
Fans, occupancy period, W/m²			n/a	
Fans, non-occupancy period, W/m²			n/a	

Part 8: Domestic hot water systems

Quantity	l/m²year	400[7]
Temperature difference	°C	36.7[8]
Distribution efficiency	%	95
Automatic control %	%	?
Generation efficiency %	%	73
Energy source (fuel, energy carrier)	-	Natural gas
Pumps, DHW system	W/m²	Unknown

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	n/a
Sundays	°C		h/day	n/a
Unoccupied period	°C			n/a
Holidays	°C			n/a

Part 10: Cooling system

Emission efficiency	%	n/a
Distribution efficiency	%	n/a
Automatic control	%	n/a
Generation efficiency	%	n/a
Fans/pumps room units	W/m²	n/a

[7] http://ec.europa.eu/environment/water/quantity/pdf/Water%20Performance%20of%20Buildings_Study2009.pdf
[8] Measurement oh domestic hot water consumption in dwellings, energy saving trust

Pumps cooling system	W/m²	n/a

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	n/a
Sundays	°C		h/day	n/a
Ventilation rate, occupancy period, m³/hm²			n/a	
Ventilation rate, non-occupancy, m³/hm²			n/a	
Heat recovery efficiency, %			n/a	
Night – cooling, m³/hm²			n/a	
Free – cooling, m³/hm²			n/a	
Emission efficiency,%			n/a	
Distribution efficiency, %			n/a	
Automatic control, %			n/a	
Generation efficiency, %			n/a	
Fans, occupancy period, W/m²			n/a	
Fans, non-occupancy period, W/m²			n/a	
Fans, night cooling, W/m²			n/a	
Fans, free-cooling, W/m²			n/a	

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

II. Category: Educational buildings

Subcategory: Schools

Table UK2: Educational buildings, School

Building category		**School**
Subcategory		**Secondary school**
Conditioned area	m^2	11 156
Conditioned volume	m^3	42 416
Climatic zone		Ref. number: WC08LON - Current CIBSE

		TRY/DSY Hourly Weather Data Set - London City: London	
Part 1: Building (Zone) geometry			
Walls, north	m^2	1124	
Walls, east	m^2	721	
Walls, south	m^2	1202	
Walls, west	m^2	545	
Windows, north	m^2	449	
Windows, east	m^2	99	
Windows, south	m^2	459	
Windows, west	m^2	177	
Roof	m^2	5343	
Floor	m^2	5343	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 0,45	Requirement at 2014 0,30[9]
ΔUtb	W/m^2K	Calculation based on psi-values	
b(ground)	-	Included in U-values	
b(un-conditioned space)	-	Included in U-values	
b(adjacent sunspace)	-	Included in U-values	
b(adjacent building)	m^2	Included in U-values	
Uwindows	W/m^2K	Prior to investment 3,3	Requirement at 2014 1,8
fraction of the window frame area	%	10[10]	
g(F)	-	0,7	
Uroof	W/m^2K	Prior to investment 0,5	Requirement at 2014 0,18
Ufloor	W/m^2K	Prior to investment 0,45	Requirement at 2014 0,25
ε	-	0,93[11]	
α	-	0,65	
Infiltration, occupancy period	h^{-1}	1	
Infiltration, non occupancy	h^{-1}	1	

[9] Approved Document L2B

[10] Default value from NCM modelling guide for buildings other than dwellings in England

[11] Values for typical brick wall, http://www.solarmirror.com/fom/fom-serve/cache/43.html

Thermal capacity	Wh/m^2K	38[12]
Part 3: Internal gains and operational schedule		
Sensible Metabolic heat (occupants)	W/m²	72[13]*978[14]/11,156=6.3
Latent metabolic heat	W/m²	n/a
Weekdays	h/day	8
Saturdays	h/day	0
Sundays	h/day	0
Lighting for illumination	W/m²	10
Weekdays	h/day	14
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m²	Can be neglected compared to lighting for illumination
Weekdays	h/day	n/a
Saturdays	h/day	n/a
Sundays	h/day	n/a
Appliances	W/m²	5
Weekdays	h/day	14
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	n/a
Weekdays	h/day	n/a
Saturdays	h/day	n/a
Sundays	h/day	n/a

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	5	2	10	5	0	15	20	0	5	0	9

Part 5: Heating mode

	Set-point temperature	Duration

[12] 600mm brick wall
[13] https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/3059/3/EIS%2325%20Havenith%207June07%20FINAL.pdf
[14] National average from government

Weekdays	°C	18[15]	h/day	12
Saturdays	°C	18	h/day	12
Sundays	°C	18	h/day	12
Unoccupied period	°C	12		
Holidays	°C	12		

Part 6: Heating system		
Emission efficiency	%	?
Distribution efficiency[16]	%	90
Automatic control	%	n/a
Generation efficiency	%	61
Energy source (fuel, energy carrier)	-	Natural gas
Fans/pumps room units	W/m²	?
Pumps heating system	W/m²	?
Pumps pre-heating ventilation	W/m²	?

Part 7: Mechanical ventilation system (heating mode)

	Supply temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	n/a
Sundays	°C		h/day	n/a
Ventilation rate, occupancy period, m³/hm²			n/a	
Ventilation rate, non-occupancy, m³/hm²			n/a	
Heat recovery efficiency, %			n/a	
Emission efficiency, %			n/a	
Distribution efficiency, %			n/a	
Automatic control, %			n/a	
Generation efficiency, %			n/a	
Energy source (fuel, energy carrier)			n/a	
Fans, occupancy period, W/m²			n/a	
Fans, non-occupancy period, W/m²			n/a	

Part 8: Domestic hot water systems		
Quantity	l/m²year	300[17]

[15] Department for Education and Skills, Energy and Water Management, A Guide for Schools
[16] Taken to be Seasonal Coefficient of Performance (SCoP)

Temperature difference	°C	36,7[18]
Distribution efficiency	%	95
Automatic control %	%	n/a
Generation efficiency %	%	61
Energy source (fuel, energy carrier)	-	Natural gas
Pumps, DHW system	W/m²	Unknown

Part 9: Cooling mode

	Set-point temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	n/a
Sundays	°C		h/day	n/a
Unoccupied period	°C			n/a
Holidays	°C			n/a

Part 10: Cooling system

Emission efficiency	%	n/a
Distribution efficiency	%	n/a
Automatic control	%	n/a
Generation efficiency	%	n/a
Fans/pumps room units	W/m²	n/a
Pumps cooling system	W/m²	n/a

Part 11: Mechanical ventilation system (cooling mode) ONLY EXTRACT VENTILATION

	Supply temperature		Duration	
Weekdays	°C	n/a	h/day	13
Saturdays	°C	n/a	h/day	0
Sundays	°C	n/a	h/day	0
Ventilation rate, occupancy period, m³/hm²			n/a	
Ventilation rate, non-occupancy, m³/hm²			n/a	
Heat recovery efficiency, %			n/a	
Night – cooling, m³/hm²			n/a	
Free – cooling, m³/hm²			n/a	

[17] Conserving Water in Further Education Colleges, Building for the Future - Sustainable Construction for Professionals
[18] Measurement of domestic hot water consumption in dwellings, energy saving trust

Emission efficiency,%	n/a
Distribution efficiency, %	n/a
Automatic control, %	n/a
Generation efficiency, %	n/a
Fans, occupancy period, W/m²	n/a
Fans, non-occupancy period, W/m²	n/a
Fans, night cooling, W/m²	n/a
Fans, free-cooling, W/m²	n/a

Part 12: Appliances not influencing the thermal balance

	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	

III. Building category: Administrative/Office

Subcategory: 1960s Office block

Table UK3: Administrative buildings/1960s Office block

Building category		**Office**
Subcategory		**1960s office block**
Conditioned area	m^2	2987,64
Conditioned volume	m^3	8845
Climatic zone		Ref. number: WC08LON - Current CIBSE TRY/DSY Hourly Weather Data Set - London City: London
Part 1: Building (Zone) geometry		
Walls, north	m^2	410,16
Walls, east	m^2	283,81
Walls, south	m^2	338,23
Walls, west	m^2	285,14
Windows, north	m^2	234,96
Windows, east	m^2	170,11
Windows, south	m^2	252,90
Windows, west	m^2	175,65
Roof	m^2	648,01

Floor	m^2	648,01	
Part 2: Building (Zone) properties			
Uwalls	W/m^2K	Prior to investment 1,60	Requirement at 2014 0,30[19]
ΔUtb	W/m^2K	Calculation based on psi-values	
b(ground)	-	Included in U-values	
b(un-conditioned space)	-	Included in U-values	
b(adjacent sunspace)	-	Included in U-values	
b(adjacent building)	m^2	Included in U-values	
Uwindows	W/m^2K	Prior to investment 6,29	Requirement at 2014 1,8
fraction of the window frame area	%	10[20]	
g(F)	-	0,85	
Uroof	W/m^2K	Prior to investment 2,8	Requirement at 2014 0,18
Ufloor	W/m^2K	Prior to investment 0,53	Requirement at 2014 0,25
ε	-	0,93[21]	
α	-	0,65	
Infiltration, occupancy period	h^{-1}	1,5	
Infiltration, non occupancy	h^{-1}	1,5	
Thermal capacity	Wh/m^2K		
Part 3: Internal gains and operational schedule			
Sensible Metabolic heat (occupants)	W/m²	6,7	
Latent metabolic heat	W/m²	2,2	
Weekdays	h/day	10	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting for illumination	W/m²	15	
Weekdays	h/day	12	
Saturdays	h/day	0	
Sundays	h/day	0	
Lighting, emergency/controls	W/m²	Can be neglected compared to lighting for illumination	

[19] Approved Document L2B
[20] Default value from NCM modelling guide for buildings other than dwellings in England
[21] Values for typical brick wall, http://www.solarmirror.com/fom/fom-serve/cache/43.html

Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	
Appliances	W/m²	15
Weekdays	h/day	12
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m²	unknown
Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	3	0	0	2	2	0	0	2	0	0	0	5

Part 5: Heating mode

	Set-point temperature		Duration	
Weekdays	°C	22**Error! ookmark not defined.**	h/day	13
Saturdays	°C	12	h/day	13
Sundays	°C	12	h/day	13
Unoccupied period	°C	12		
Holidays	°C	12		

Part 6: Heating system

Emission efficiency	%	?
Distribution efficiency	%	90
Automatic control	%	n/a
Generation efficiency	%	89
Energy source (fuel, energy carrier)	-	Natural gas
Fans/pumps room units	W/m²	?
Pumps heating system	W/m²	?
Pumps pre-heating ventilation	W/m²	?

Part 7: Mechanical ventilation system (heating mode)				
	Supply temperature		**Duration**	
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	n/a
Sundays	°C		h/day	n/a
Ventilation rate, occupancy period, m³/hm²			n/a	
Ventilation rate, non-occupancy, m³/hm²			n/a	
Heat recovery efficiency, %			n/a	
Emission efficiency, %			n/a	
Distribution efficiency, %			n/a	
Automatic control, %			n/a	
Generation efficiency, %			n/a	
Energy source (fuel, energy carrier)			n/a	
Fans, occupancy period, W/m²			n/a	
Fans, non-occupancy period, W/m²			n/a	

Part 8: Domestic hot water systems		
Quantity	l/m²year	400[22]
Temperature difference	°C	36,7[23]
Distribution efficiency	%	95
Automatic control %	%	?
Generation efficiency %	%	73
Energy source (fuel, energy carrier)	-	Natural gas
Pumps, DHW system	W/m²	Unknown

Part 9: Cooling mode				
	Set-point temperature		**Duration**	
Weekdays	°C	24	h/day	13
Saturdays	°C	24	h/day	13
Sundays	°C	Off	h/day	0
Unoccupied period	°C	Off		0
Holidays	°C	Off		0

[22] http://ec.europa.eu/environment/water/quantity/pdf/Water%20Performance%20of%20Buildings_Study2009.pdf
[23] Measurement of domestic hot water consumption in dwellings, energy saving trust

Part 10: Cooling system: Local air conditioning only		
Emission efficiency	%	90
Distribution efficiency	%	80
Automatic control	%	n/a
Generation efficiency	%	?
Fans/pumps room units	W/m²	?
Pumps cooling system	W/m²	0,90

Part 11: Mechanical ventilation system (cooling mode)				
	Supply temperature		Duration	
Weekdays	°C	17	h/day	13
Saturdays	°C	17	h/day	13
Sundays	°C	Off	h/day	0
Ventilation rate, occupancy period, m³/hm²				
Ventilation rate, non-occupancy, m³/hm²				
Heat recovery efficiency, %			n/a	
Night – cooling, m³/hm²			n/a	
Free – cooling, m³/hm²			n/a	
Emission efficiency,%			90	
Distribution efficiency, %			80	
Automatic control, %			n/a	
Generation efficiency, %				
Fans, occupancy period, W/m²				
Fans, non-occupancy period, W/m²				
Fans, night cooling, W/m²				
Fans, free-cooling, W/m²				

Part 12: Appliances not influencing the thermal balance			
	Average simultaneous power	Duration	
Weekdays	W/m²	h/day	
Saturdays	W/m²	h/day	
Sundays	W/m²	h/day	